

NRW PMO Strategic Outline Case

Executive Summary

The Ynysybwl Flood Risk Management project, and as such this business case, is primarily focused on the fluvial flood risk arising from the Nant Clydach to residential properties on Clydach Terrace, Ynysybwl. The work undertaken to date has highlighted a potential residual pluvial (surface water) flood risk to the properties and flood risk to properties on Windsor Place. These risks, along with the primary focus, will be investigated in more detail during the subsequent Outline Business Case (OBC) stage, should it be approved.

The properties along Clydach Terrace have a history of flooding and experienced rapid, deep inundation in February 2020, during Storm Dennis. Flood hazard is increased by the very flashy nature of the upstream catchment. The frequency and intensity of flooding in Ynysybwl is predicted to increase due to the impacts of climate change.

The properties are currently offered some standard of protection from fluvial flooding by a highway wall, situated along the road which runs parallel to the properties at Clydach Terrace. However, the maintenance and repair of this structure is currently under the jurisdiction of Rhondda Cynon Taf County Borough Council and its performance as a flood risk management asset is uncertain.



Figure 1 – Highway wall on Clydach Terrace (looking upstream)

The Strategic Outline Case (SOC) has assessed available data, including hydraulic modelling outputs, flood records, anecdotal evidence, stakeholder engagement and an Initial Assessment (undertaken by NRW in 2022-2023), to identify longlist and shortlist flood risk management options.

Key to the success of the project will be continued engagement with the local community, who have a wealth of knowledge in the area; and the consideration of all wellbeing objectives, Sustainable Management of Natural Resources (SMNR) principles and project Critical Success Factors (CSF). In addition, the SOC assesses the wider benefits of each

option beyond flood risk management, such as wellbeing of the local community and net environmental impacts.

A range of options have been identified at the longlist stage, including the construction of a purpose-built flood risk management wall, downstream de-culverting, upstream natural flood management (NFM), installation of a Flood Warning System, offline flood storage, increasing the capacity of the watercourse, debris management, removal of properties at risk, property flood resilience (PFR) measures and raising the levels of existing properties. The Walkaway and Business as Usual options have also been included as part of the longlist as economic baselines for comparison with potential options.

The longlist options have been appraised against the CSFs. A shortlist of three options has been identified based on those options considered to have the potential to fulfil the CSFs. An economic assessment has been undertaken to determine the present value damages, benefits, and value for money of the shortlisted FRM options in accordance with HM Treasury Green Book and Welsh Government Flood Risk Management Business Case Guidance.

This SOC has identified flood risk management options that, under the current detail of scrutiny, remain economically and technically viable. At this stage of appraisal, a preferred option has not been recommended, it is recommended that the shortlisted options are taken forward to OBC stage for further consideration and investigation.


Project Details

Project timeframe	Start date:	30/06/2023	End Date:	01/04/2029
Project name	Ynysybwl Flood Risk Management Project			
Directorate	Operations			
Leadership	Operations			
Programme (if applicable)	FRM			
Location (if applicable)	Ynysybwl			
National Grid Reference (if applicable)	N/A			

Project Roles	Name	Post Title
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NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

Project Manager	Alexia Dimitriou	Project Manager (PPD)
Project Executive	Mark Groves	Project Executive (PPD)
Budget Manager		Head of Flood & Incident Risk Management
Programme Manager (if applicable)		Manager, Flood Risk Strategic Planning and Investment
Senior Responsible Owner (SRO)		Head of Flood and Incident Risk Management
Senior User (or Expert User Group)		Operations Manager (Flood & Water Management)

Risk Potential Assessment (RPA) Score	Medium
Risk Potential Assessment (RPA) (please provide location / hyperlink here, or indicate if appended to rear)	 Risk Potential Assessment FINAL.xls
Project Runway	Runway 3
Justification for Project Runway selection	Project total forecast >£2M RPA Medium Risk

Strategic case

Strategic Context

Ynysybwl flood risk management project, and as such this business case, is primarily focused on the fluvial flood risk from the Nant Clydach to properties situated on Clydach Terrace, Ynysybwl.

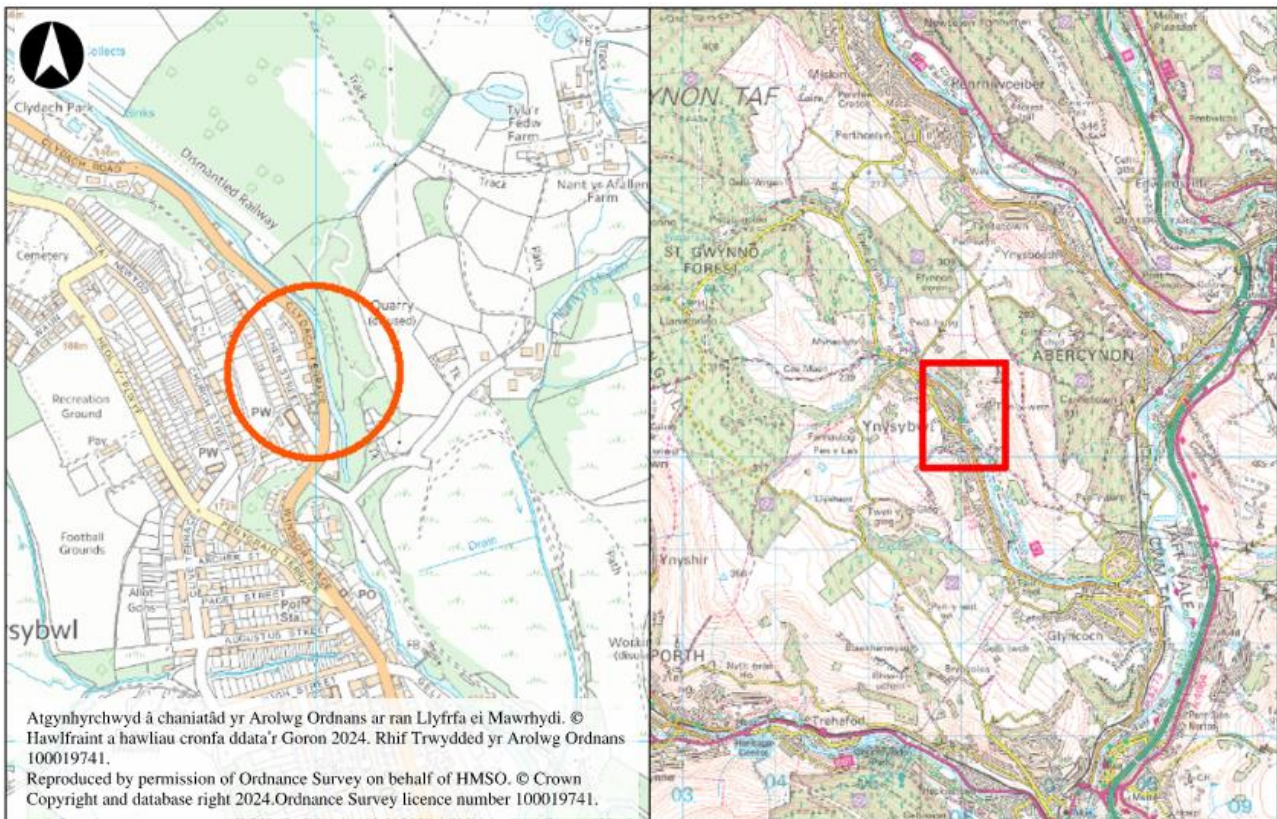


Figure 2: Location Plan; Clydach Terrace

In summary, this SOC includes an assessment of the flooding problem and identifies potential suitable flood risk management measures, from the long list options identified during the Initial Assessment, to progress. It presents the case for formal approval of costs to develop an OBC, which will aim to identify a preferred option.

Ynysybwl is a village situated in the valley of Clydach, which forms part of the Nant Clydach catchment, which extends approximately 17km² upstream. The NRW managed forestry estate in the catchment above Ynysybwl, also plays a great role in the strategic fit of this project in line with the business needs, and the local [Forest resource Plan](#) can be relied upon for the optioneering and pragmatic solution strategy of this project. The Nant Clydach, which is classified as a main river, is a tributary of the River Taff. The watercourse is short and steep, prone to shoaling, and is in a confined upland valley where its course is flanked by residential properties. Clydach Terrace lies on the floodplain in a very constrained section of the valley and has historically suffered from severe flooding from records dating back to 1955. Notably during Storm Dennis in February 2020, flood waters from the Nant Clydach overtopped the wall which runs along the length of the terrace, with records of internal flooding to 16 properties. Flooding was significant with reports that the street was so rapidly inundated with flood water

that residents did not have time to respond and the internal flood depths to the lowest lying homes reached 1.96m. Two photographs of the recorded flood depth in this event are provided on Page 16.



Figure 3 – Shoal build-up in the river channel just off of Clydach Terrace

The map below shows the properties flooded during storm Dennis, along with key features along Nant Clydach.

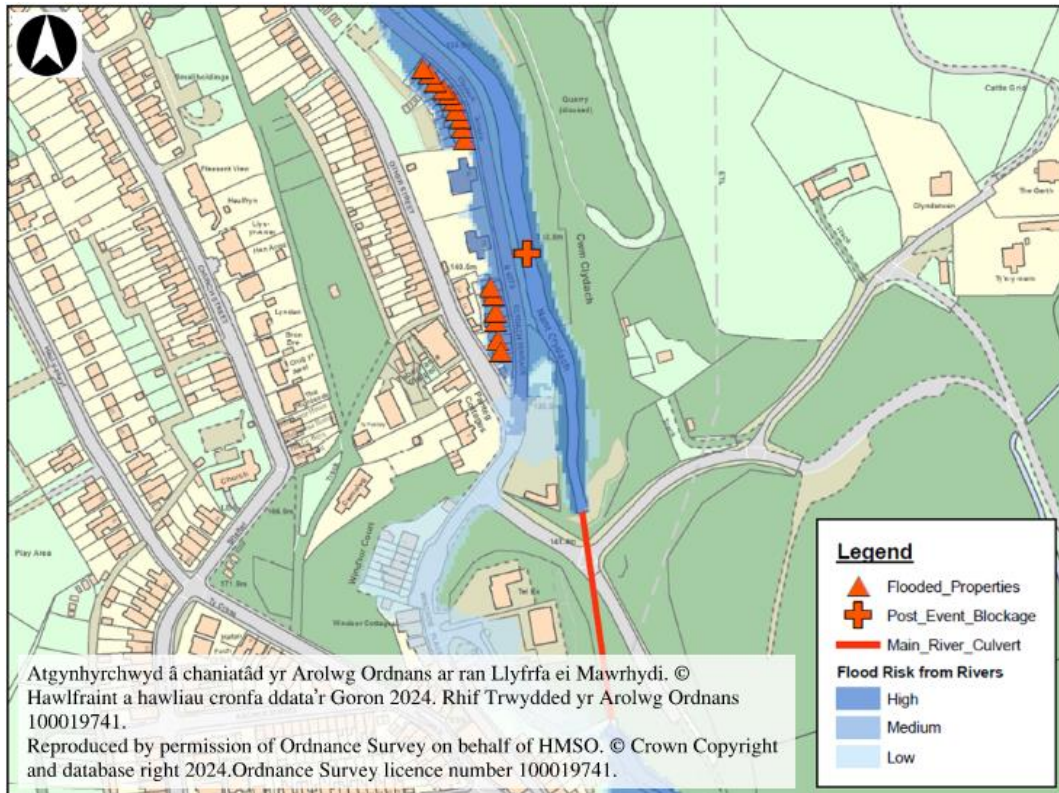


Figure 4: Map of Nant Clydach

The Nant Clydach is covered by the Taff and Ely catchment flood management plans CFMP (2009), it forms part of policy unit 3 – Clydach, Lower Cynon, Taff Vale.

Following the aftermath of Storm Dennis, NRW developed a direct rainfall flood model and undertook an Initial Assessment to better understand the flood risk and undertake a high-level assessment of potential flood risk management options. No flood studies of the Nant Clydach had previously been undertaken by NRW or its predecessor bodies. The direct rainfall approach used within the modelling study has meant that both the fluvial flood risk from the Nant Clydach, and the pluvial flood risk can be assessed. Where an option provides better flood risk management from flooding arising from the Nant Clydach, surface water flooding may form a residual risk to properties. In addition to the potential residual pluvial flood risk identified, flood risk to properties on Windsor Place has been identified, both fluvial and pluvial during the present-day scenarios and as potential detriment from some options considered. These risks, will be investigated in more detail during the subsequent Outline Business Case (OBC) stage, should it be approved.

A 1995 Catchment Management Plan referenced the difficulty in providing a flood warning services at Ynysybwl 'since the river's response is too rapid'. It remains that there is no local warning system for the Nant Clydach.

NRW currently has no flood risk management assets in Ynysybwl although the wall acts as a de facto flood asset, even though its original purpose may not have been so. The wall is likely the jurisdiction of RCTCBC Highways. The construction and long term performance of the asset as an appropriate flood risk management asset is not fully known.

National Strategy for Flood and Coastal Erosion Risk Management

The National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in Wales, as required under the Flood and Water Management Act 2010, sets the framework for managing flood and coastal erosion risks across Wales.

Every flood risk management action undertaken in Wales must aim to fit with overarching National FCERM Strategy objectives. This assessment will aim to contribute to the following objectives:

1. Improving our understanding and communication of risk

NRW has developed a direct rainfall model, improving the baseline understanding of the level of risk to the local community. Our understanding of the risks will be further developed through the appraisal of flood risk management options.

Communication with the local residence and wider stakeholders will be key to the success of this project. Initial engagement has been held, advising on the likely timescales for delivery. Throughout, the project the team will develop and manage a communications plan to inform stakeholders of our findings.

RCTCBC have been engaged to better understand the current condition and residual life of the wall. Further investigation may be undertaken in future to better understand this.

2. Preparedness and building resilience

Currently, there are no flood risk management assets that directly benefit Clydach Terrace or Winsor Place. In addition to this project, NRW has installed a gauge board to allow monitoring of river levels. An aim of the project is to identify the most viable flood risk management solution.

3. Prioritising investment to the most at-risk communities

Fluvial flooding in Ynysybwl is predicted to directly impact 16 properties in the present day 2% AEP flood event. In significantly larger events, more properties in the wider area are also shown to be at risk of fluvial flooding. The modelling assessment indicates that there is a residual risk of surface water flooding in the community. Ynysybwl has a fluvial max rank of 147 on the NRW Communities at Risk Register (CaRR). The CaRR has been developed to provide an objective means of identifying risk and prioritising flood risk management activities at a Wales-wide, community level. It allows the level and distribution of flood risk to be quantified across Wales using a standard methodology across all flood sources to calculate a theoretical 'Danger' score, by using outputs from flood models to consider the number of people at risk, the hazard they are exposed to over a range of probabilities, the speed of onset of flooding and their ability to respond in terms of social vulnerability to flooding. It also uses factors such as availability and standard of flood warnings and flood risk management assets. Using WG's Scoring Methodology this community's score is 63.

4. Preventing more people becoming exposed to risk

During the assessment process, NRW will assess the impact of potentially viable flood risk management options to consider if they will cause adverse impacts elsewhere, if required, detriment mitigation measures will be considered to address this issue.

5. Providing an effective and sustained response to events

NRW's Initial Assessment recommended further investigation in to flood risk management options through the development of this business case.

The latest FCERM strategy incorporates new legislation that has been introduced since 2010, that fundamentally influences how flood risk management is undertaken in Wales:

- Well-Being of Future Generations (Wales) Act 2015
- Environment (Wales) Act 2016
- Planning (Wales) Act 2015

The Environment (Wales) Act and The Well-being of Future Generations (Wales) Act and Corporate Plan

NRW has a duty under the Well-being of Future Generation (Wales) Act to maximise its contribution to the seven well-being goals, supported by the corporate plan and area statements.

In response to requirements under the Well-being Act and the Environment (Wales) Act, NRW developed Well-Being Objectives to contribute to the delivery of the Well-Being Goals and ensure the principles of SMNR throughout its functions. NRW's Corporate Plan is delivered via NRW Well Being Objectives. The following table provides a summary of project opportunities to align with the Well Being Objectives:

Table 1 NRW Well-being Objectives

NRW Well-being Objective	Example Project Opportunities
<p>Nature is recovering</p>	<p>Take a holistic approach, identifying wider benefits, not just flood risk management that support community cohesion and resilience, and mental and physical health.</p> <p>Provide enhancement opportunities and consider nature based solutions where viable e.g. natural flood management, building the resilience of ecosystems.</p> <p>Achieve biodiversity net benefit and provide ecosystems with greater diversity and connectivity.</p> <p>Implement measures to contribute to the control of invasive non-native species (INNS) which are known in the area, pests</p>

NRW Well-being Objective	Example Project Opportunities
	and diseases, where species have widespread negative impacts on the economy, environment and people's health.
Communities are resilient to climate change	<p>Consider the impacts of climate change on flood risk and include flood resilience within the options appraisal assessment.</p> <p>Identify a range of options that consider:</p> <ul style="list-style-type: none"> land and water issues holistically, recommending management options that maximise SMNR to reap multiple benefits management of flood risk into the future, including allowances for predicted climate change. Water quality and quantity, identifying opportunities that will contribute to their improvement, benefiting both people and ecosystems.
Pollution is minimised	<p>Implement whole life carbon assessment as a key performance indicator within the procurement strategy.</p> <p>Engage with supply chain early to appraise options that provide resource efficiency and implement where feasible the use of alternative materials.</p>

South Central Wales Area Statement

Natural Resources Wales has published seven 'Area Statements'. The Area Statements can be seen as a collaborative response to what is known as the Natural Resources Policy, published by the Welsh Government in 2017, which sets out the key challenges and opportunities for the sustainable management of Wales' natural resources into the future. Each Area Statement outlines the key challenges facing that locality, what can be done to meet those challenges, and how management of natural resources can be improved for the benefit of future generations.

The South Central Area Statement is dominated by a desire to bridge the urban and the natural environments. It consists of five key themes – sets out to address the legacies of the past along with the challenges and opportunities of the future, exploring ways to work together to protect, value and embrace the natural environment.

Working with Water is identified as a key theme. Within that theme there are many opportunities which overlap with the project desires including:

- Maintaining, enhancing and restoring floodplains and hydrogeological systems to reduce flood risk and improve water quality and quantity
- Restoring uplands and managing them for biodiversity, carbon, water, flood risk, energy and recreational benefits

- Increasing green infrastructure in and around urban areas
- Reducing the risk of flooding

Flood Risk Management Plan for Wales: South Central Wales

Flood Risk Management Plans (FRMP) cover all of Wales and provide information on the scale of flood risk, as well as NRW's priorities for managing the risk of flooding, and measures proposed to take, over the coming years. NRW's FRMPs cover flooding from rivers, reservoirs and the sea. They do not include flooding from surface water and smaller watercourses. The FRMP fulfills NRW's requirements under section 25 of the Flood Risk Regulations (2009) but also takes into account recent fluvial and coastal flooding events and subsequent work arising from them.

The South Central Wales Area Statement identifies Working with Water as a key theme. The information and proposed actions within the FRMP are directly relevant to this challenge and set out NRW's flood risk management ambitions to help address it. The South Central Wales Place section provides information about the level of risk at a local scale and describes what NRW has planned for the communities that we are most concerned about. In line with Welsh Government's National Flood and Coastal Erosion Risk Management Strategy Objectives, NRW prioritise work and direct efforts on a prioritised flood risk basis to communities at greatest risk of flooding. This uses the CaRR that considers a number of factors (such as the number of people at risk, flood hazard, speed of onset of flooding, social vulnerability and availability of existing FRM measures such as flood risk management assets and flood warning service) to identify the communities at greatest risk of flooding across the South Central Wales area. As mentioned above, the CaRR is used to inform, plan and prioritise the NRW FRM investment programme, targeting investment in the most at risk communities. Ynysybwł is identified as one of the communities at most risk of flooding in the Area Statement, the FRMP identifies the following work to be delivered in Ynysybwł:

- Undertake initial assessment and feasibility work for reducing flood risk
- Investigate feasibility for new flood warning service
- Build hydraulic model

A direct rainfall fluvial model has been built and an Initial Assessment undertaken, this project will build on this to undertake feasibility work for reducing flood risk.

Local Flood Risk Management Plan: Rhondda Cynon Taff

As the Lead Local Flood Authority (LLFA), RCTCBC is currently updating the Local Flood Risk Management Strategy and supporting Action Plan¹. Local flood risk is defined as flood risk from surface water runoff, groundwater and ordinary watercourses. Ynysybwł falls within the Lower Cynon Strategic Flood Risk Area Action Plan. The plan notes that there are no communities in the Lower Cynon that fall within the top 5% (top 111 nationally) of

¹ Rhondda Cynon Taf County Borough Council, March 2024 – Flood and Water Management Act 2010 Local Flood Risk Management Strategy and Action Plan DRAFT
(<https://www.rctcbc.gov.uk/EN/GetInvolved/Consultations/CurrentConsultations/PublicConsultationontheDraftLocalFloodRiskManagementStrategyandActionPlan.aspx>)

communities at greatest risk of pluvial flooding in Wales but that Ynysybwl is the highest community at risk of pluvial flooding in Lower Cynon (ranked 177). The consultation draft includes the proposed action: “Clydach Terrace FAS (Main River Flooding) - *The LLFA will cooperate with NRW as the RMA for main river flooding who are leading on the development of a business case to manage the risk of main river flooding. (ref SFRA8A3)*”.

Objectives

The key Ynysybwl flood risk management project objectives were agreed with the project team as provided in Table 2. There is potential scope for additional wellbeing and environmental enhancements aside from the management of flood risk, which is included in Table 20 – Project Products.

Table 2 Project Objectives

SMART	Objective description	Indicator	Timescale
1	<p>Specific: Reduce flood risk to 16 properties located at Clydach Terrace</p> <p>Measurable: Use direct rainfall model to assess current level of flood risk and appraise options to reduce flood risk to properties</p> <p>Achievable: This will be achieved by procuring consultants from existing supply chain who have the skills, knowledge and experience to produce the model outputs</p> <p>Realistic: Increasing the level of protection is a realistic objective given no formal flood management asset(s) currently exist</p>	Achieved once there is indication that that the preferred option can reduce the risk of flooding to the residents, and such an option identified has been constructed and is in operation.	Implementation of the preferred option is expected to be delivered by 2029.
2	<p>Specific: To avoid service failure and long term Operational Expenditure (OPEX) maintenance costs</p> <p>Measurable: Use data from the operations team to measure long term maintenance costs associated with de-shoaling and INNS management. Undertake</p>	The objective will be considered as achieved once long term maintenance costs reduce, and the current standard of protection is maintained or improved.	Implementation of the preferred option is expected to be delivered by 2029.

	<p>structural assessment of the existing highway wall.</p> <p>Achievable: This can be achieved through the utilisation of existing information from the operations team, and through procuring supply chain resource to undertake a structural assessment of the highway wall</p> <p>Realistic: Reducing OPEX cost is a realistic objective as part of the implementation of any flood management assets</p>		
3	<p>Specific: Contribute to the well-being objectives as described in the NRW Well-being statement, (such as 2. A resilient Wales and 2. A healthier Wales) and the SCW Area Statement</p> <p>Measurable: Option appraisals will be measured against the well-being objectives, seeking to contribute to as many as reasonably practicable</p> <p>Achievable: This will be achieved as part of the appraisal process</p> <p>Realistic: This is a realistic objective, as any solution will need to demonstrate contribution towards the well-being objectives</p>	Achieved once the assessment of the preferred option shows positive contribution to the well-being objectives.	Implementation of the preferred option is expected to be delivered by 2029.
4	<p>Specific: Contribute to SMNR principles (such as scale, collaboration & engagement, public participation, preventative action, building resilience etc)</p> <p>Measurable: The principles of SMNR will be embedded throughout the project process and examples of ways of working recorded.</p>	Achieved once the assessment of the preferred option shows positive contribution to the NRW's Well-Being Objectives.	Implementation of the preferred option is expected to be delivered by 2029.

	<p>Achievable: This will be achieved by ensuring options consider the SMNR principles, i.e. maintain and or enhance biodiversity and identify wider opportunities for ecosystem resilience such as Natural Flood Management (NFM).</p> <p>Realistic: This is a realistic objective, SMNR has been successful embedded into the process on previous projects.</p>		
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Existing Arrangements

No NRW flood risk management assets are currently present at Ynysybwl. The 1.2m high wall running along the highway of Clydach Terrace acts as a de facto flood risk management asset, providing the current standard of protection. RCTCBC (highways) conducted a structural assessment of the wall to determine its condition following Storm Dennis. The present day condition and expected residual life of the wall is not currently fully understood by the project team.

Information gathered in the aftermath of Storm Dennis in February 2020, indicated that prior to overtopping of the highway wall, Clydach Terrace was already experiencing flooding which was assumed to be from surface water. Residents suggested to NRW that the highway wall first overtopped at the downstream end of the street.

The river is prone to shoaling which reduces the channel capacity which is likely impacting flood risk. NRW and its predecessor bodies have undertaken channel maintenance to remove shoal material from the river channel. Around 500 tonnes of river shoal material was removed from the channel adjacent to Clydach Terrace, as shown below, in July 2020. This work was repeated more recently in March 2023, where a further 220 tonnes of material was removed from the riverbed.



Figure 5 – Deshoaling length within river

A number of residents have signed up for a Flood Alert for the nearby River Cynon, under the assumption that raised water levels in the adjacent catchment may be an indicator of raised levels in the Nant Clydach. Whilst this may give warning of the potential of elevated levels, it is likely some events will go without any form of warning.

Local drainage systems also appear to be under capacity to meet current needs and during periods of moderate rainfall, local reports suggest they are subject to surcharging causing problems of their own. Demountable flood gates have been supplied by the council to mitigate the risks associated with this.

Need / Opportunity

The most recent flood events were during Storm Dennis in February 2020, resulting in internal flooding to 16 properties. Records dating back to 1955, show periodic flooding within the area. A summary of these are listed in the table below, noting the properties affected and impact recorded.

Table 3 Flood History

Date	Properties Affected	Additional Comments
1955	Unknown	6 th & 7 th June 1955. River flooding of properties and highway. JBATrust data – British Chronology of Flash Floods indicates that a heavy short duration rainfall event occurred on the 6 th June 1955.

		<ul style="list-style-type: none"> Pontypridd – 2.92in 40mins (74mm) Merthyr Tydfil – 1.5in 96mins (38mm) <p>At Ynysybwl:</p> <ul style="list-style-type: none"> Rain flooded many houses up to the ground floor ceilings. Many residents had to be rescued from upstairs rooms. The road to Pontypridd was blocked by a landslide.
1960	1	<p>4th December 1960. River flooding of highway, 1 public house.</p> <p>The following rainfall totals were recorded on 3rd December 1960.</p> <ul style="list-style-type: none"> Mountain Ash – 5.43in / 137mm. Clydach Reservoir – 5.4in / 135mm. <p>Records show the Mountain Ash gauge recorded 17.52in / 445mm for the previous month (November 1960).</p>
1979	2	<p>27th December 1979. No7 & No8 Clydach Terrace. Flooded due to river level restricting operation of drains. (Surface Water)</p>
1998	0	<p>22nd to 31st October 1998. No property flooding. Highway was flooded from surface water and potential overtopping from main river.</p>
2020	16	<p>16th Feb 2020 (Storm Dennis). Flood depths ranged from 300mm to 1.9m.</p> <p>No River Telemetry available for this catchment. However, Nant yr Ysfa rain gauge recorded 130.4mm in the 24hrs leading up to 7am 16th February 2020. This equates to 72% of February LTA rainfall at this location. Initial hydrology estimates this to be around 1in30yr rainfall event.</p>

Following the aftermath of Storm Dennis, NRW undertook and post flood event investigations which included a threshold level survey at properties impacted and the survey of a wrack mark from Storm Dennis at No7 Clydach Terrace:

- Property Threshold Level – 134.027m AOD
- Storm Dennis Wrack Mark – 135.988m AOD
- Storm Dennis Observed Depth – 1.96m

The two photographs shown in Figure 6 below indicate the observed flood depths at Clydach Terrace, these serve to illustrate the significant danger posed by the flooding during Storm Dennis.

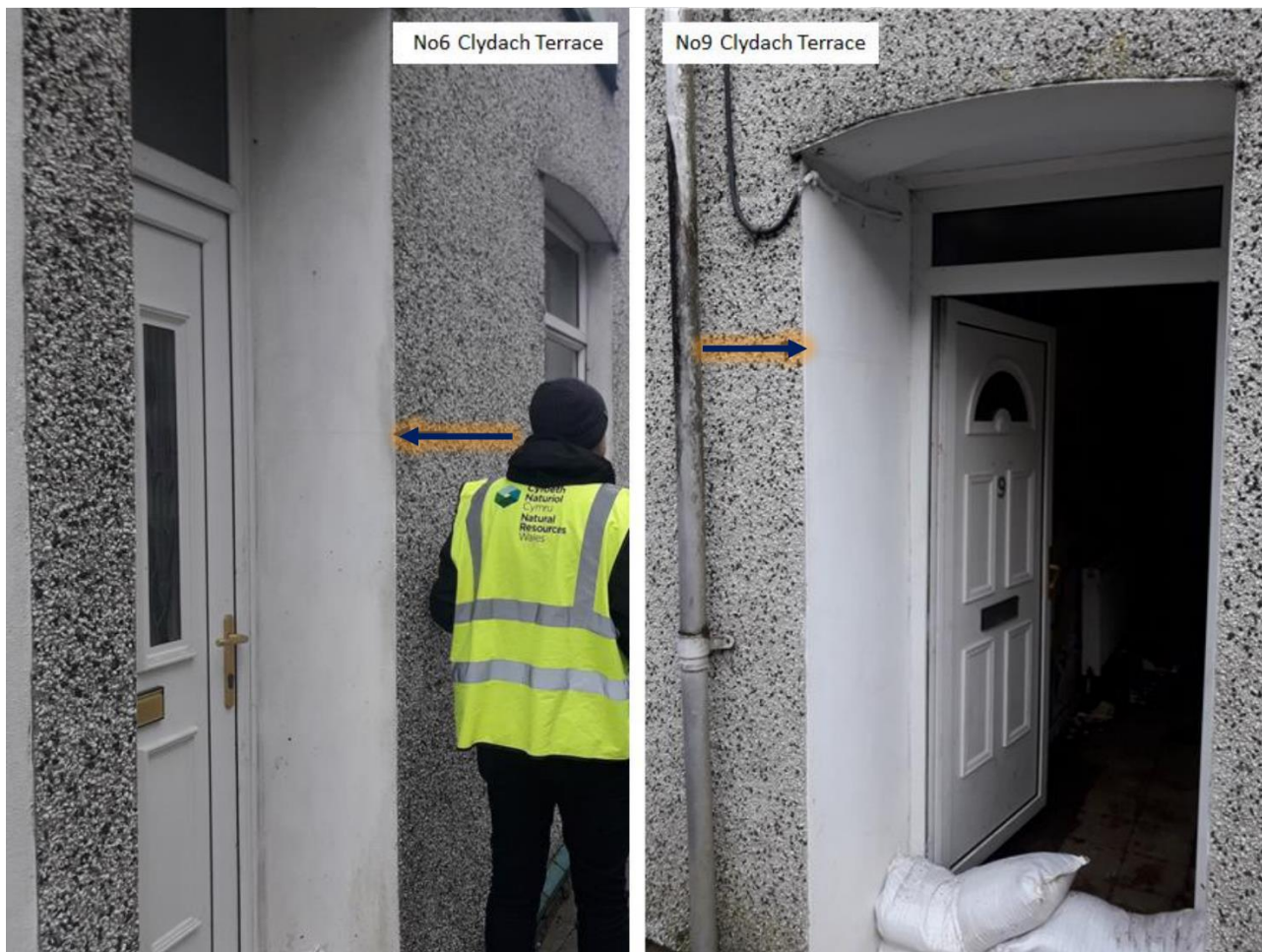


Figure 6 Height of flooding observed at two properties on Clydach Terrace during Storm Dennis

Scope

The current scope of the project is to reduce the risk of fluvial flooding to properties at Clydach Terrace.

The aim of this SOC is to establish viable options for reducing fluvial flood risk arising from the Nant Clydach. It is proposed to extent this scope during the OBC to include the properties along Windsor Place, should further investigations identify these properties as being at high flood risk in the Business As Usual (BAU) scenario or at detriment due to any proposed actions, and pluvial flood risk, by working in partnership with RCTCBC.

Project Considerations

Study Area: The SOC study area covers properties along Clydach Terrace and considered flood risk management options throughout the Nant Clydach catchment.

Landowners, stakeholders and public support: The delivery of a successful FRM project is directly associated with broad support from the stakeholders. Landowner compensation and or purchase of land may be required. NRW's SMNR principles are being applied throughout this project, to promote collaboration, stakeholder and public participation, and

reinforce collaboration and cooperation for key decisions. The SOC has followed a Communications Plan prepared and managed by NRW to identify, understand, and engage with key landowners, stakeholders, and the wider local community.

Environmental impacts: A Preliminary Ecological Appraisal (PEA) and a Strategic Environmental Review (SER) have been created as part of this SOC. Those have identified a number of potential environmental impacts and potential opportunities for environmental improvement, associated with each option. These will be incorporated into planning and delivery, and realised upon completion, to maximise the contribution to NRW's Well Being Objectives.

The PEA report conducted as part of this SOC has identified a number of Sites of Special Scientific Interest (SSSI) and Sites of Importance for Nature Conservation (SINCs), as well as protected and notable species within the study area.

The SER states that the study area falls within Clydach SINC, Lower Clydach Woodlands SINC, and Y Ffrywd SINC. These SINCs form a complex mosaic of habitats, linked by the valley of the Nant Clydach.

The SER identifies that as part of the Ynysybwl flood risk management project, there are a number of potential opportunities to improve biodiversity and resilience of ecosystems, land management, soil management, improve or enhance the WFD status of the Nant Clydach and landscape and visual amenity. The opportunities or constraints from an environmental perspective will be dependent on the options taken forward to OBC stage.

The SOC has identified a number of potential environmental impacts associated with the long listed and short listed options. In particular, hydrological disruption, an increase in air, water, and/or noise pollution, visual or vibrational disturbance during construction and/or operation, and habitat loss/disruption. Further information regarding the specific environmental and ecological impacts and constraints for each of the longlisted options is provided in the Longlist Options Appraisal, appended in the Products Section of this report.

Suitable mitigation, and where not possible, compensation measures will be identified through the environmental appraisal process, in addition to opportunities for environmental and social enhancements. Consequently, it is considered that the potential environmental impacts can be appropriately managed for the project options and do not represent a major risk, constraint, or dependency. Opportunities also exist to fulfil SMNR project objectives through the environmental and social enhancement opportunities.

Health & Well-Being: The existing threat of fluvial flooding during a flood event is detrimental to the health and well-being of the residents. Flood risk mitigation measures improve mental and physical health, by reducing the ongoing fear and worry related to flooding. There is also the potential for wider community health and well-being benefits. However, any detrimental impacts of the project to health and well-being would need to be considered also.

An EqIA report has been produced to better understand the specific positive or negative impacts of the longlisted and shortlisted options on those people who have a protected characteristic. The EqIA will be further updated at OBC stage when a recommendation has

been made regarding the preferred option or combination of options for the project. At that point, specific actions for mitigating any adverse impacts can be identified. Further information regarding the positives and negatives of each of the longlisted options is provided in the Longlist Options Appraisal found in Table 9.

Constraints and Exclusions

Nant Clydach adjacent to Clydach Terrace is a designated SINC. This highlights its ecological significance, where the conservation of flora, fauna and other features is deemed important. The designation as a SINC implies that the site holds ecological value, and any actions taken within the area will consider avoidance of potential negative impact on the environment, and should this not be possible, then appropriate mitigation will be implemented. There are no SSSI or Special Areas of Conservation (SAC) in the immediate vicinity of the properties, however there are in the wider study area. These will need to be considered should flood risk management options that interact with these designations show potential.

Permissions and consents: Permissions and consents may be required to deliver the preferred option. This may include Environmental Impact Assessment (EIA) screening in accordance with the Town and Country Planning (EIA) (Wales) Regulations 2017, planning permission, Flood Risk Activity Permit(s) and protected species licences.

Utilities: There are utilities, including a combined sewer, water main and gas main, that are located in proximity to the of potential long list options. The understanding of the existing utility and service infrastructure is informed by statutory undertaker asset records however further investigation will be required to assess the exact location and extent of utilities infrastructure and services in the study area. The presence of this infrastructure is a potential constraint on any potential construction methodology and may further inform the suitability of any proposed FRM option.

Dependencies

To successfully deliver the project objectives, several requirements from other programmes as well as Forestry (see [Forest resource Plan](#)), such as FRM maintenance, or parties, such as the LLFA, may be essential.

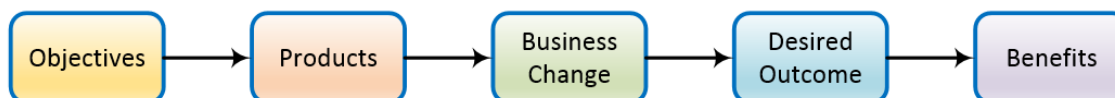
Obtaining permits or consents for working in water bodies, activities related to highways, and complying with regulations related to protected species will be necessary for works to commence.

Collaboration with RCTCBC to align any existing highway drainage maintenance plans with the project activities to ensure the effectiveness and integration of the preferred option to any existing plans.

There may be scope for the Taff Catchment: Strategic Management Plan to influence the project depending on its findings and recommendations, however that work is in very early stages, and due to the political and public implications of Clydach Terrace, this project cannot allow for time to wait for the Taff Strategy findings.

Benefits

Projects deliver products, which are used to bring about business change. The outcomes are the change brought about by using the project products. The benefit is the measurable improvement resulting from the outcome.



A FRM project in Ynysybwl will reduce the flood risk to the 16 properties on Clydach Terrace, which flooded during Storm Dennis, and potentially the wider community such as Windsor Place. The project will reduce both the current flood risk, and will act to mitigate the increasing future flood risk as a result of climate change.

Further, there may be opportunities to provide environmental benefits, including those which promote biodiversity and improve the natural environment. A further benefit of the project is the reduction in long term operational expenditure and resource demand. The benefits of the project are summarised in Table 4.

Table 4 Benefits of the Project

Benefit Description	Benefit Owner
Reduced fluvial flood risk for the 16 properties at risk of flooding at Clydach terrace	Operations Manager (Flood & Water Management)
Reduced long term OPEX costs and resource demand	Operations Manager (Flood & Water Management) Operations Manager (Land & Assets)
Achieve Biodiversity net benefit	Operations Manager (Flood & Water Management)

Risks

A summary of the high level risks associated with undertaking this project is given in Table 5. The project risk register will continue to be developed and managed during the OBC stage. This will be reviewed at key milestones throughout the project lifecycle.

Table 5 Summary of Project Risks

No	Key Project Risk	Mitigation Plans
1	Detriment for which there is no mitigation or is not acceptable to	Design mitigation for detriment caused. Early consultation with property owners

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

	property owners, leading to objections to planning application.	<p>affected to assess likelihood of avoiding objections. .</p> <p>Early consultation has been undertaken with NRW FRA team. Any Flood Consequence Assessment (FCA) required for a recommended option, will be developed and submitted in the detailed design phase of works, prior to submitting the Full Business Case (FBC) and requesting approval for delivery.</p>
2	Insufficient funds – Welsh Government Grant in Aid, and Risk Management Authority partnership funding	The project will be submitted to the PMO and FRM Business Board for assurance and to the financial approver at each business case stage, with details of financial forecasts which include risk allowances. This will allow programme leads to consider the project in an affordable programme and align timing of delivery to suit funding availability.
3	Lack of evidence to support case for change	<p>The SOC has produced a number of long list options and used the flood model to evidence benefits for each.</p> <p>Project economics and technical delivery were assessed in the Initial Assessment and have been refined in this SOC, in accordance with Welsh Government FCERM Business Case Guidance, to ensure the project is only progressed further if it remains viable.</p> <p>Be clear about modelling and economic sensitivities and present upper and lower limits where possible.</p>
4	Residual Flood Risk	An assessment of the residual flood risk (hazard) for each recommended option will have to be undertaken for exceedance events and for above proposed Standard of Protection to determine if this is at an acceptable level. This would need to be screened against a benchmark model which would incorporate amongst other factors, speed of onset, depth, and velocity.

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

5	Residual hazard	Assessments of the residual hazard will be undertaken across all options, and over all stages of the project.
6	Reputational damage if no project option is economically or technically viable - Project has become high profile locally with involvement of MS and there is a keen interest from the community.	Clearly explain Welsh Government FCERM Business Case Guidance and FRM Capital Funding System to key stakeholders. A communication strategy has been developed by the project team. The community and key stakeholders will be kept updated with project progress.
7	Stakeholders don't support the short-listed options and agreements can't be reached to take them forward.	Short listing of options will require further consultation to ensure that options are acceptable to affected parties and relevant stakeholders. Where required compensation estimates will be included in option estimates.
8	Flood risk could be originating from multiple sources such as surface water or sewer overload which could undermine some of the benefits of managing the fluvial risk only.	NRW will work with the LLFA and the sewerage undertaker (Dŵr Cymru Welsh Water) to better understand the sources of flood risk and any potential options or plans to manage respective risks.
9	All required permissions and consents for the chosen option may not be obtained	Permissions and consents may need to be obtained in relation to the project. These could include a Flood Risk Activity Permit and planning permissions. During the OBC stage, required permissions and consenting will be identified for any recommended options.
10	Negative environmental impacts	Negative environmental impacts will be avoided where possible. Where necessary environmental field surveys will be undertaken. Mitigation strategies or compensation packages will be developed for any potential unavoidable negative impacts of any recommended option. Opportunities for net improvements in the natural environment will be screened via desk based assessment, any promising avenues that

		align with the project will be further explored.
11	Public misconception (of flood risk or options to manage)	Undertake detailed public engagement sessions at each stage of the project lifecycle, educating people on the process guidance in developing a flood risk management option. Produce a detailed communications plan and implement effectively throughout

Key Stakeholders and Working with Others

Table 6 provides a summary of the key stakeholders for the project. It is likely that further engagement with these stakeholders will be required at future stages of project delivery.

Table 6 Summary of Key Stakeholders

Stakeholders
External:
<u>Welsh Government – Senedd</u> <ul style="list-style-type: none"> - Beth Winter MP for Cynon Valley - Vikki Howells MS for Cynon Valley - Heledd Fychan MS for SWC <p>Interest: MP representing their constituents</p> <p>Opportunities: Stakeholder working group, comms lead with residents</p>
<u>Rhondda Cynon Taf County Council (RCTBC)</u> <p>Interest: LLFA, Highway Authority, Planning Authority and Emergency Planners</p> <p>Opportunities: Collaborate with Highways Department on options appraisal and funding</p>
<u>Residents of Clydach Terrace</u> <p>Interest: Residents at risk from flooding</p> <p>Opportunities: Community stakeholder group</p>
<u>National Flood Forum (NFF)</u> <p>Interest: Flood Action Group</p> <p>Opportunities: Community stakeholder group</p>
<u>Utilities (DCWW)</u>

Interest: Protection of assets (upstream Reservoir)
Opportunities: Improve collaborative working
Internal:
Head of Operations South Wales Central
Operations Manager (Flood & Water Management)
Team Leader Environmental Assessment Team
Team Leader People & Places Team
Team Leader Asset Performance
Team Leader Integrated Engineering
Team Leader Forest Operations
Team Leader Land Management
Evidence, Policy and Permitting
River Restoration – Freshwater Ecosystems and Fisheries Management

The Stakeholder Engagement Plan for this project is combined with the Communications Plan, [and can be found stored on the DMS here](#). A copy can be made available on request.

Knowledge share

To better understand the issues which have impacted previous, similar projects, a knowledge share study has been undertaken which has included the identification of lessons learnt. The topic, cause and impact to the project is discussed in Table 7.

Table 7 Summary of Knowledge Share

Have you reached-out to seek similar projects within NRW and understand lessons learned?	Yes
IF YES: Which similar projects have you identified and what lessons learnt are relevant you this project?	

Project	Topic	Cause	Impact
Pwllheli Flood Risk Management Scheme	Miss alignment of expectations and scope with FRA Team on the hydraulic and hydrological modelling submission.	Limited direct communication between the Arup's modelling team and NRW's FRA Team.	Delay to programme (circa 4 weeks). Increased costs associated with revisiting modelling work.
Pwllheli Flood Risk Management Scheme	The hydrology element of the modelling was submitted and received at the time as the hydraulic model.	Lack of protocol i.e. confirm agreement of hydrology approach with NRW prior to progressing to hydraulic modelling.	Delay to programme. Duplication of works/effort to retrospectively address the issue.
Porthmadog FRM Project	Production of a template for contacting statutory undertakers about their flood risk.	Flood model update showing infrastructure at greater risk.	Improved communication with third parties to seek to influence action.
Wemyss	Email from Stakeholder outlining the need for a narrative document or information of what advice has been taken forward from previous stages of consultation. Consultees are unaware of what they previously said and if it has been absorbed into the project.	Poor communication following stakeholder engagement	Confusion during next phase of consultation. Stakeholders were not sure how their advice had been incorporated or forgot what they had said.
Wemyss	Local stakeholders requesting site meeting to review options being consulted on. This has come to light	Partially low-quality documentation. Partially lack of understanding by stakeholder.	Additional cost and time.

	on Pandora where the information shared to stakeholders is not great quality. Farmer is requesting we talk through the options on site so he understands. The technical note has gone through Comms review, to ensure it is a simple to follow as possible.		
Llwynypia	Appraisal, Design, Construction of flood assets adjacent to utilities (DCWW)	Utilities asset immediately adjacent to NRW asset potential to impact project viability	Abortive spend
Ammanford FRMS	Flood Risk Modelling	Alignment with fish passage project led to late modelling of options and potential detriment mitigation optioneering became critical path.	Additional time and cost.
Ammanford FRMS	Data	Good understanding of services in locality and sufficient time in programme to allow for diversions. Sufficient time risk allowance in programme for planning consent.	Programme saving.

Economic case

Critical Success Factors

The Critical Success Factors (CSFs) can be defined as attributes essential to the successful delivery of a project. The CSFs are used to assess the potential options that have been identified. For an option to be considered viable, it must have the potential to meet all of the CSFs. It cannot be considered viable if it can only meet some of the identified CSFs, or can only partially meet a CSF. A summary of the identified CSFs is given in Table 8.

Table 8 Critical Success Factors

No.	Critical Success Factor (CSF)	Description of CSF
1	Strategic fit and business needs	An option that reduces present day and future flood risk to people and property in Clydach Terrace, Ynysybwl, to improve the quality of life to the local community. An option that aligns with WBO and SMNR objectives.
2	Potential value for money	An economically viable option to manage flood risk, with a Benefit Cost Ratio (BCR) greater than one.
3	Supplier capacity and capability	The option must match the capacity and capabilities of potential suppliers.
4	Potential affordability	An affordable option for WG FRM funding within financial year constraints, taking into account estimated costs.
5	Potential achievability	A technically feasible option to manage flood risk, with consideration of site-specific constraints, noting the need for consenting and community / homeowner support, with a maintainable option.

Options Analysis – Long List

The following table summarises the Long List Options Framework, which will be used to identify options to be taken forward to Longlist stage. This table has been populated subsequent to discussions with key stakeholders and decision makers. According to the FCERM Guidance, the framework considers the creation of options as a series of choices to be made in sequence. The first set of questions namely “Where” and “What” will assist the appraiser in identifying the potential scopes for a project which will include: the Walkaway option, the Business As Usual option, a minimum of two intermediate options, and a Do Maximum option. Options should be ordered from least to most ambitious, in terms of outcomes. The framework then asks that appraisers identify and appraise the choices in relation to the “How”, “Who”, “When” and “Funding”. The Walkaway and Business as Usual options have been automatically carried forward for comparison with identified options.

Table 9 Longlist Options Framework

Project	Walkaway	Business as Usual	Intermediate Option 1	Intermediate Option 2	Intermediate Option 3	Do Maximum
1a.Service scope (spatial) – as outlined in strategic case	nil	Assets currently in place	Property scale	Local scale (Clydach Terrace)	Community scale	Catchment scale
	Carried Forward	Carried Forward	Carried Forward	Carried Forward	Carried Forward	Preferred Way Forward
1b.Service scope (temporal) – as outlined in strategic case	nil	Assets in place (existing Standard of Protection (SoP))	20% AEP SoP (2020-2039, 5% climate change allowance)	2% AEP SoP (2020-2039, 5% climate change allowance)	1% AEP SoP (2020-2039, 5% climate change allowance)	0.1% AEP SoP (2020-2039, 5% climate change allowance)
	Carried Forward	Carried Forward	Discounted	Carried Forward	Preferred Way Forward	Discounted

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

Project	Walkaway	Business as Usual	Intermediate Option 1	Intermediate Option 2	Intermediate Option 3	Do Maximum
2. Service Solution – in relation to the preferred scope	Current services: Cessation of maintenance activities	Core services: Continuation of current activities	Core + Desirable services: reduce fluvial flood risk and maintain solution.	Core + Desirable services: reduce fluvial flood risk and maintain solution, plus amenity and biodiversity enhancement.	No Intermediate Option 3 for Service Solution.	Core + Desirable + Optional services ² : reduce fluvial flood risk and maintain solution, plus amenity and biodiversity enhancement, plus further local biodiversity enhancements and scour protection.
	Carried Forward	Carried Forward	Discounted	Carried Forward		Preferred Way Forward
3. Service Delivery – in relation to preferred scope and solution	nil	Current arrangements: local Asset Management team	Local Framework: RMA project team plus local consultants and contractors	Wales framework: RMA project team plus Wales-wide consultants and contractors	No Intermediate Option 3 for Service Delivery.	UK framework: RMA project team plus open tender and Find a Tender Service (FTS)
	Carried Forward	Carried Forward	Carried Forward	Preferred Way Forward		Discounted

² As included in the FCERM guidance Service Solution table P.68 [flood-and-coastal-erosion-risk-management-fcerm-business-case-guidance_0.pdf \(gov.wales\)](#)

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

Project	Walkaway	Business as Usual	Intermediate Option 1	Intermediate Option 2	Intermediate Option 3	Do Maximum
4.Implementation – in relation to preferred scope, solution and method of service delivery	nil	Continue current activities	<1 year	1-3 years	3-6 years	6+ years
	Carried Forward	Carried Forward	Discounted	Carried Forward	Preferred Way Forward	Discounted
5.Funding – in relation to preferred scope, solution, method of service delivery and implementation	nil	Revenue funding (public)	Capital funding (public)	Capital funding (public) via innovative funding mechanism e.g. FCERMP	No Intermediate Option 3 for Funding.	Capital funding (public) plus external contributions
	Carried Forward	Carried Forward	Carried Forward	Preferred Way Forward		Discounted

A summary of the decisions made to refine the longlist definition is provided below.

Service scope (spatial): The preferred option would be to provide a solution at the catchment scale. However, other options at the property, local and community scale will be considered. These have been carried forward.

Service scope (temporal): The 20% AEP SoP has been discounted as it is not considered to provide a substantial increase in flood protection. An SoP of the 0.1% AEP event has been discounted as it is considered that it would be difficult or technically infeasible to provide protection measures in an event of this magnitude. The 2% AEP and 1% AEP SoP have been carried forward as providing this SoP as part of the project is considered feasible and would provide an improved SoP over the existing situation.

Service Solution: The Preferred Way Forward would provide the Core + Desirable + Optional services set out in the scope. The Core + Desirable services plus amenity and biodiversity enhancement has been carried forward as an attainable solution. The option with Core + Desirable services comprising reduction in flood risk and maintenance of the solution has been discounted as it does not provide a significant wider benefit.

Service Delivery: The Wales framework has been identified as the Preferred Way Forward, with the Local Framework carried forward³. This provides the most options in terms of service delivery when considering the potential project complexity and programme requirements.

Implementation: An implementation timescale of <1 year has been discounted as it is not considered realistic. Implementation periods of 1-3 years or 3-6 years have been Carried Forward with 3-6 years as the proposed timeframe, as it is considered most realistic.

Funding: Capital Funding has been carried forward as an established method of financing FCERM projects in Wales. Capital funding plus external contributions has been discounted as it is not considered to be an option in the study area. Capital funding via an innovative funding mechanism, such as FCERMP, has been chosen as the Preferred Option.

As a result of the input received from key decision makers and stakeholders, the Options Framework filter has now set the parameters for options to be carried forward for the development of a Long List of FCERM Measures.

Long List Options Appraisal

An initial list of potential flood risk management options has been developed based on a series of discussions between project stakeholders, and project team.

The following series of tables provides a summary of each longlist option, a qualitative assessment of estimated cost, the potential advantages and disadvantages of each option and an assessment against the CSFs. This assessment has been used to determine whether each individual option should be taken forward to the shortlist for further appraisal.

³FCERM guidance, SWOT Temporal Scale table p.67 [flood-and-coastal-erosion-risk-management-fcerm-business-case-guidance_0.pdf \(gov.wales\)](#)

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

**Baseline options Walkaway (WAW) and BAU, which must be considered, have been added to the end of this table.*

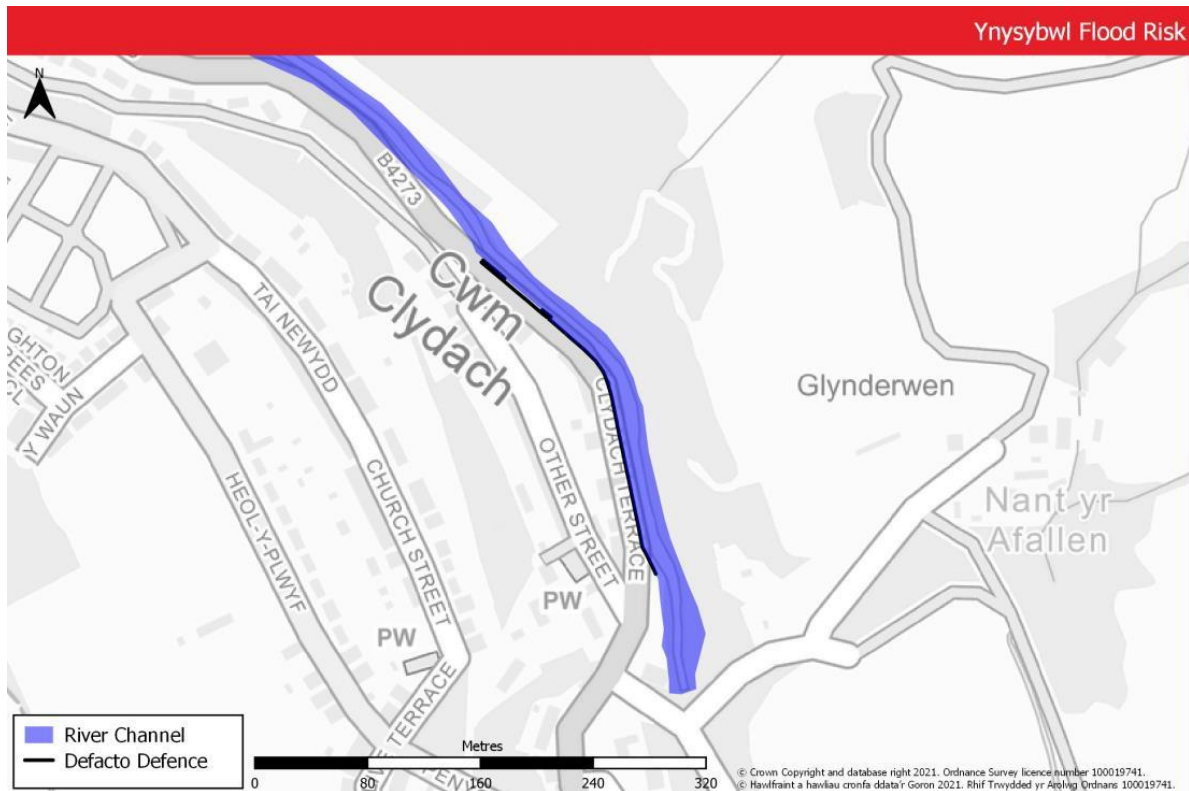



Figure 7 – Plan of existing highway wall on Clydach Terrace



Figure 8 – Highway wall on Clydach Terrace (looking downstream)

Option 1	
Description	Raise and upgrade existing highway wall. Replacing and raising the existing highway wall at Clydach Terrace so it performs as a formal flood risk management asset, offering an improved SoP.

Option 1	
	<p><i>Figure 9 – Raising and upgrading existing wall (photo montage of 1 %AEP height wall outside No.4/5 Clydach Terrace)</i></p>
Costs	<p>Anticipated high cost relative to WAW and BAU options.</p>
Advantages	<ul style="list-style-type: none"> • Model indicates that raising the height of the wall reduces the risk of fluvial flooding to properties and people on Clydach Terrace. • Social and wellbeing value in terms of the residents knowing their homes are at a lower risk of fluvial flooding. • Potential reduction in other maintenance costs, including shoal removal as wall improves on the existing SoP, design can improve access, or might not be impacted by shoal being managed by natural processes. Reduction in post flood event costs including clean up as wall reduces risk of fluvial flooding to properties.
Disadvantages	<ul style="list-style-type: none"> • The increased wall height (compared to existing) will become a greater visual barrier to the river. • Road may need to become single carriageway and there may be encroachment towards the riverbank resulting in habitat loss. • Potential for loss of habitat through requirement for continuing the ongoing channel maintenance which could result in a reduction of quality of aquatic habitat for fish and invertebrates.

Option 1	<ul style="list-style-type: none"> • Operational maintenance required by NRW, if the asset is adopted by NRW. Maintenance is likely the responsibility of RCTCBC. • Potential for habitat disturbance/loss should vegetation clearance be required. • There is little space along B4273 road and therefore this would likely need to be closed during construction. Alternative route through Ynysybwl is not as suitable as main route through the village. • Potential disproportionate impact to people with reduced mobility, who may be more severely impacted by road closures or reduced vehicular access to properties on Clydach Terrace. • Medium carbon cost associated with construction of the new wall; this may be minimised by selection of materials and construction methods. • A secondary flooding mechanism is observed where surface water flow ponds behind the wall. This residual risk reduces the effective SoP of the option. • Flood and hazards during exceedance events remain.
Assessment against Critical Success Factors	<p>This option satisfies the strategic fit and business needs, as the hydraulic modelling has indicated that this option can provide a reduction to fluvial flood risk at Clydach Terrace.</p> <p>The improved SoP offered by the option is likely to improve the quality of life of the residents. However, some residents have expressed concerns that the option will reduce other aspects of their quality of life by disconnecting them from the river, impacting light levels, reducing parking availability for vehicles, and further negatively impact the value of their property when compared to current values while exposed to high risk of flooding</p> <p>Option is economically viable and provides value for money. The option remains affordable, taking into account estimated costs.</p> <p>The option matches the capacity and capability of potential suppliers.</p> <p>The option remains technically feasible, though consideration must be given to site-specific constraints such as utilities infrastructure. The option is maintainable.</p> <p>Potential to meet all CSFs.</p>
Conclusion	Shortlisted.

Option 2	
Description	<p>Natural Flood Management (NFM)</p> <p>Implement NFM in upper catchment. There are possible opportunities upstream, including using Welsh Governments' Woodland Estate at Llanwonno Forestry.</p>
Costs	Low cost for NFM option alone
Advantages	<ul style="list-style-type: none"> • Incorporating NFM measures will somewhat reduce flows into Nant Clydach, along with potential benefits elsewhere in terms of ecology and the environment. • NFM could result in an increase in riparian habitat complexity, reduction in sediment, shoal, woody debris, transportation downstream and creation of microhabitats beneficial for a range of aquatic/semi-aquatic species. • NFM option would support Part 1 of the Environment (Wales) Act; 'sustainable management of natural resources', which puts priority on nature based solutions. • Less new embodied carbon spend vs other options.
Disadvantages	<ul style="list-style-type: none"> • NFM alone will not reduce flood risk to desired levels, as indicated by high level appraisal. • Agreement with owners of upstream land and purchase may be required, which can be difficult and time consuming to achieve
Assessment against Critical Success Factors	<p>Preliminary assessment of potential flood flow reduction was undertaken at Initial Assessment stage using the Flood Risk Assessment Wales Economic Toolset (FRAW ETS) and identified that maximum flow reduction achievable by implementing NFM measures in the South East valleys basin is 26.9%, comparative to the climate change uplift values for the Severn basin. The assessment concluded that potential reductions in peak flows provided by NFM are likely to be nullified by increased in flood flows as a result of climate change.</p> <p>As such, the NFM option alone is unlikely to significantly reduce fluvial flood risk to people and property on Clydach Terrace both now and in future. However, the option would still provide some benefit in terms of flood risk and the option aligns with SMNR principles.</p> <p>The NFM option is likely to be affordable and provide value for money, especially when considering the wider ecological and environmental benefits.</p> <p>The option matches the capacity and capability of potential suppliers.</p> <p>The option is technically feasible.</p>

Option 2	
	It is considered that the NFM option is unlikely to meet the CSFs. However, the NFM option has the potential to partially meet all CSFs and therefore could be considered in combination with other option/s.
Conclusion	Not a standalone option because the impact on flood risk is considered to be low, but potential for NFM to be incorporated in combination with preferred option as will enhance benefits. Further consideration to be given at OBC.

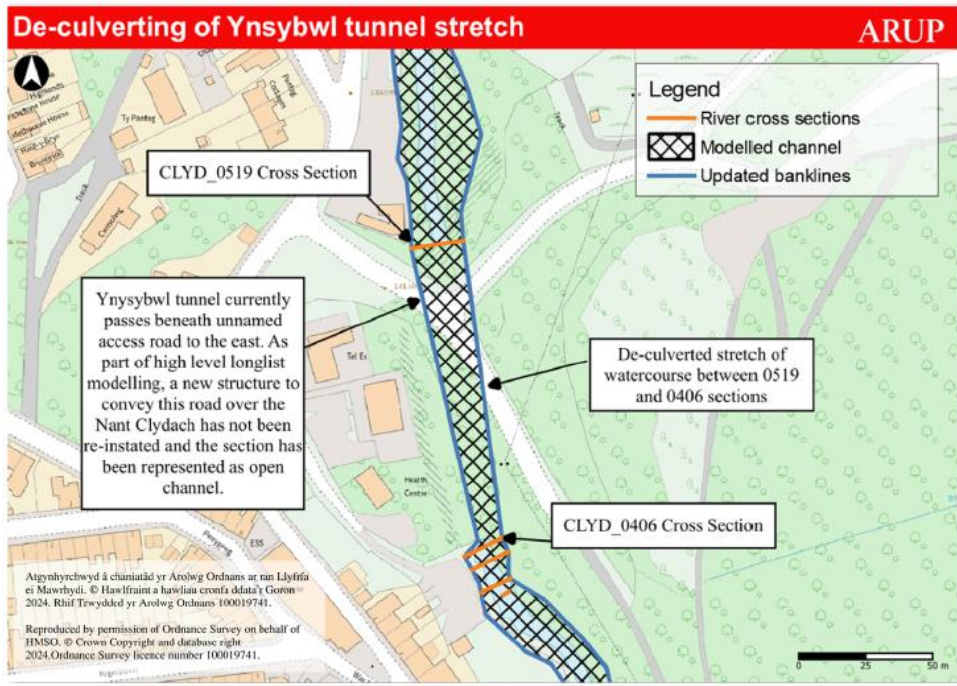
Option 3	
Description	Remove people & properties at high hazard from flooding Properties will be purchased, and residents will move away from the flood risk area.
Cost	High cost - <i>*Includes high level valuation of the properties to be purchased and the cost of demolition and remediation.</i>
Advantages	<ul style="list-style-type: none"> • No present day or future flood damage costs to properties at Clydach Terrace, that are at a high risk of deep, rapid, internal, fluvial flooding. Associated reduction in maintenance costs and post-event maintenance activities including clean up somewhat reduced. • Positive social impact to residents as they do not have to live within a flood risk area. • In addition to the associated savings, potential cessation or reduction of channel maintenance would have the potential to allow the river channel to return to a more natural state. This provides potential benefits from a WFD and wider environmental point of view in terms of improving habitat complexity, with associated benefits to important riparian habitat for a range of aquatic and semi-aquatic species. • Depending on the use of this land around Clydach Terrace after demolition of the properties, there may be wider benefits including increased amenity or recreational space and ecological/environmental benefits.
Disadvantages	<ul style="list-style-type: none"> • Option would involve demolition of properties at high risk. With this, there is little space along B4273 road and would potentially require it to be closed for a period of time. Alternative route through Ynysybwl is potentially not suitable as main route through the village. Potential disproportionate impact to people with reduced mobility, who may be more severely impacted by road closures or reduced vehicular access to properties in Ynysybwl.


Option 3	
	<ul style="list-style-type: none"> • Novel 'set back' adaptation approach with wider interest/communications anticipated. • The residents of Clydach Terrace are a close knit and supportive community, with many residents having long-standing ties to the area. Relocation may weaken or break these ties and subsequently impact health and well-being. There may be a disproportionate impact on elderly people or vulnerable people who may have lived in the area for a long time. The solution broadly relies on affected properties reaching consensus. • May disproportionately impact those people with additional needs in terms of housing, as they may be less able to find comparable housing elsewhere. Children who are required to move schools would be disproportionately impacted as a result of disruption to schooling and social groups. • Medium to high carbon spend depending on the method of reinstating the area.
Assessment against Critical Success Factors	<p>Has potential to meet CSFs, but merits further investigation into its feasibility. The option would reduce present day and future flood risk to people in Ynysybwl by removing them from an area with high flood risk.</p> <p>The option has the potential to offer value for money. The option is potentially affordable.</p> <p>The option meets supplier capacity and capability.</p> <p>The option is technically feasible.</p> <p>The option is achievable based on the site constraints.</p>
Conclusion	Shortlisted.

Option 4	
Description	<p>Flood Warning System (FWS) FWS introduced, including required gauging equipment.</p>
Cost	Low cost for Flood Warning System installation alone.
Advantages	<ul style="list-style-type: none"> • Provides the residents some warning to place valuables in a safe place and evacuate the properties. Improves resident's feeling of safety as they can prepare for a potential flood event.

Option 4	
	<ul style="list-style-type: none"> • Minimal carbon spend. • Can be used in combination with other measures to improve overall risk management. May be technically easier to provide in combination with other measures.
Disadvantages	<ul style="list-style-type: none"> • Requires information from river and rain gauges along with soil moisture capacity to provide accurate warning system. Due to flashy nature of the river, adequate data is not currently available. • Costs associated with installing and maintaining gauges that provide data for the warning system. • Likely temporary habitat disruption or impacts to fish arising during the installation of gauges. • The catchment is steep and narrow, with a fast response to rainfall. In this sort of catchment, it can be difficult to install an effective flood warning system that provides enough time for residents to respond in advance of a flood event. • There may be a number of false warnings that may reduce resident response rates to a warning. • Option may be less effective for those with reduced mobility or additional needs as they may be less able to respond to the flood warning system. Elderly people may have difficulty in accessing or responding to a digital warning system.
Assessment against Critical Success Factors	<p>This option does not meet the Strategic fit and Business needs as it does not reduce the risk, through measurable change in SoP, both now and in the future. It has the potential to reduce the consequences of a flood event by giving residents advance warning. Appraisal of this option as part of the Initial Assessment stage flagged that the time to peak in the catchment can be as little as 3 hours. As such, it would be difficult to provide significant warning of an impending flood event. The Initial Assessment also flagged that the antecedent conditions heavily influence the scale of the flood event experienced at Ynysybwl during periods of increased rainfall. To be effective, the FWS would need to take this into account.</p> <p>The flood warning system alone is likely to provide value for money and would be affordable. There will be ongoing maintenance and operational costs in terms of maintaining the gauge and FWS and gathering the required data.</p> <p>The option is likely to meet both supplier capacity and capability. The option is likely to be achievable. Further work to identify the amount of flood warning and the reliability of the warning in the catchment would be required.</p>
Conclusion	Shortlisted, but not assessed further at this stage due to Welsh Government Rapid Assessment of Damages (RAD) tool methodology limitations. The RAD tool does not allow for inclusion of the benefits of

Option 4	a flood warning system, and it is considered based on appraisal at Initial Assessment stage that the Flood Warning System alone would not comprise a viable option in terms of flood risk reduction. Potential to consider further, alongside other options, at OBC stage.
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Option 5	<p>Description</p> <p>Remove/improve downstream culvert</p> <p>Existing highway wall will be upgraded to perform as flood risk management asset at its current height, and culvert will be removed or improved to not be a hydraulic restriction for events up to the design SoP.</p>  <p><i>Figure 10 – Culvert location plan</i></p>
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Option 5	 <p data-bbox="427 1084 1193 1115"><i>Figure 11 – Culvert (photo taken from the South end, looking upstream)</i></p>
Cost	Very high cost
Advantages	<ul style="list-style-type: none"> • Reduces flood risk in the 3.33% AEP scenario for all properties. • Potential for reduction in maintenance costs in terms of debris removal or reactive maintenance of the structure. • Daylighting of the watercourse in this location could provide marginal social and wellbeing benefits in terms of increased awareness and visibility of the watercourse. • Improved aquatic and riparian habitat through the reach, potential for increased re-naturalisation of channel. This aligns with the aims and objectives of the WFD. • Potential to re-establish a more natural channel profile. • Improvement in potential for fish passage and removal of barrier to otter passage up and downstream.
Disadvantages	<ul style="list-style-type: none"> • For flood events that exceed 3.33% AEP event, removal of culvert has minor impact on flood extents and depths. • Due to threshold heights of the buildings on Clydach Terrace and the flood depths observed, it is likely that, even with the culvert removed, substantial internal flooding would still occur. • De-culverting would be complex and costly as it will involve day-lighting the culvert/rock tunnel. • The culvert currently carries an over bridge, full removal would require a replacement bridge to be constructed.

Option 5	<ul style="list-style-type: none"> • The conveyance capacity of the bridge would need to be increased relative to the existing structure otherwise the de-culverting will offer little flood risk benefit. • May increase flow velocity as culvert is removed. Therefore, a geomorphological assessment will be required to assess whether there will be any longer term impacts in terms of channel morphology. Although this could also be a potential advantage if the evidence shows that sediment transport is being restricted by the culvert. • Downstream impacts to be assessed, with risk of impact on third-parties. • Will require works adjacent and in the watercourse. High flows may prohibit this and impose programme delays. • Traffic management will be required along the unnamed access road, and there will likely be a diversion required for residents to access their properties. This may be disruptive as the access to the properties from the north is via dirt tracks that may not be suitable for all vehicles. This may disproportionately impact those with decreased mobility due to the reduced vehicular access to Ynysybwl and properties to the north. • Likely temporary habitat disruption or impacts to fish arising during the construction phase. • Potential for high level of pollution during de-culverting and upgrading of highway wall. • There will be a high carbon cost associated with the removal of the culvert and also the construction of the new bridge.
Assessment against Critical Success Factors	<p>This option provides some flood risk reduction benefit in more frequent events but does not provide a reduction in larger order events, where the impact of the flood event is much greater. Hydraulic modelling has shown that the option is unlikely to prevent internal property flooding in flood events exceeding the 3.33% AEP event. As such, it is not considered to meet the Strategic fit and Business needs.</p> <p>The option is likely to be expensive and, as the reduction in flood risk is not substantial, is unlikely to provide value for money.</p> <p>The option is potentially achievable and meets the capacity and capability of the supply chain.</p> <p>The option is considered unable to meet the CSFs.</p>
Conclusion	Discounted option.

Option 6

Description

Offline Flood Storage/Reconnecting the flood plain
Existing flood plain utilised as storage.

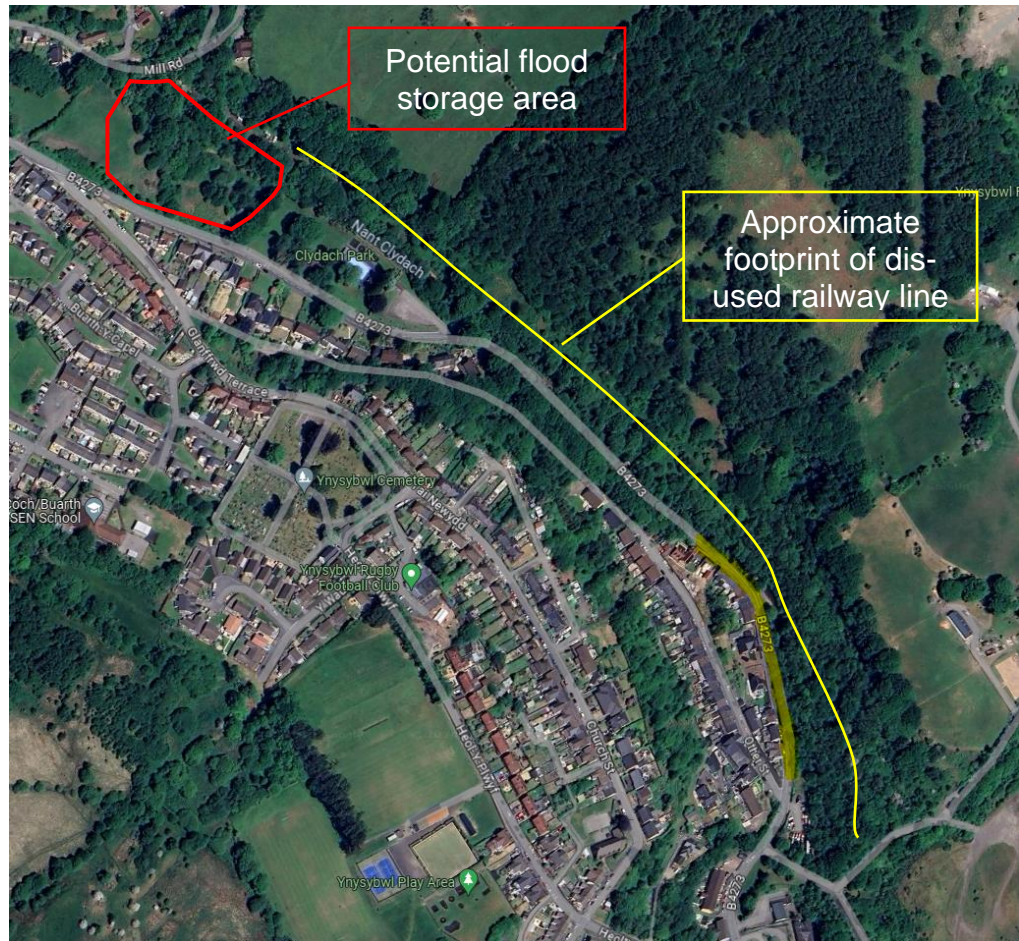


Figure 12 – Potential flood storage area map vs Clydach Terrace location

Option 6

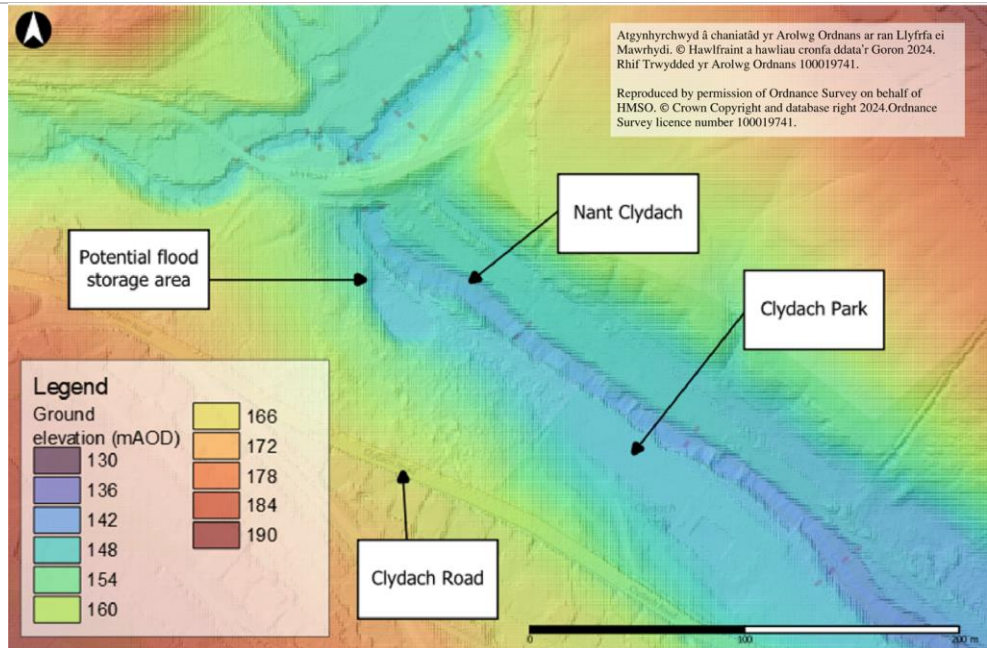


Figure 13 – Ground Elevations indicating some potential Flood Storage locations

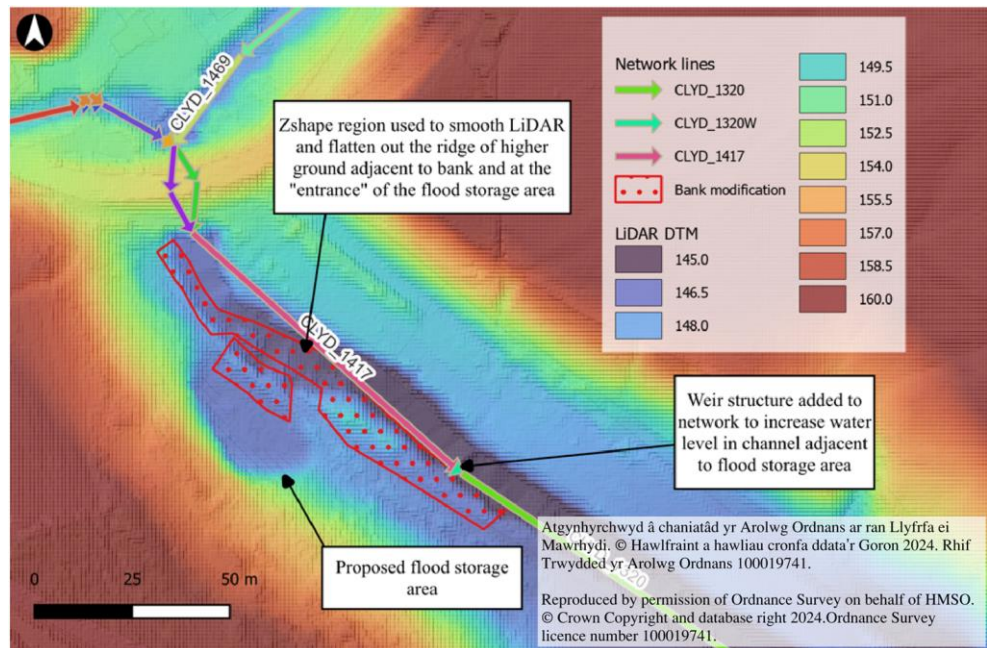


Figure 14 – Schematisation of some potential flood storage locations

<p>Cost</p>	<p>Anticipated medium/high cost</p>
<p>Advantages</p>	<ul style="list-style-type: none"> • There may be some opportunity to combine the excavation and expansion of the flood storage areas with provision of recreational or amenity spaces. • Potential for NFM storage options, such as naturalised offline ponds, which could provide a host of ecological benefits.

Option 6	
	<p>Floodplain management strategies have potential to be of value to local wildlife and habitats.</p> <ul style="list-style-type: none"> • Storage focused NFM measures are likely to be less carbon intensive compared to engineered options however a suitable location would need to be determined.
Disadvantages	<ul style="list-style-type: none"> • Model shows that flood storage area to north-west of Clydach Park fills during small flood events but does not have appreciable storage volume in comparison to capacity of watercourse and flows observed. • Significant amount of excavation would be required to achieve desirable storage volume to reduce flood risk. This material may have contamination from historic industry and will need to be transferred and disposed of, incurring additional costs. • Additional structures would be needed to control flow from flood storage back to the river. • Landownership unknown. Potential to increase project costs. • Potential visual and landscape impacts associated with the excavated areas. • Potential habitat loss and disturbance should vegetation clearance be required. • There will be a high carbon cost associated with the removal of large volumes of material.
Assessment against Critical Success Factors	<p>Assessment undertaken at Initial Assessment stage has indicated that substantial excavation would be required on the left bank (22,400m³) of the Nant Clydach to lower ground levels enough to allow water to enter the area that is currently behind the disused railway line.</p> <p>Hydraulic modelling has been used to assess the potential of utilising the area to the north of Clydach Park as flood storage. The exercise indicated that this area is likely to fill during lower order flood events and therefore does not provide substantial storage during larger flood events, where there are greater volumes of floodwater.</p> <p>The option does not meet the Strategic fit and Business need as it does not reduce the flood risk in the present day or in the future. Although there may be wellbeing benefits associated with using the flood storage area as an amenity or recreational space, it will not improve wellbeing in terms of reduced flood risk.</p> <p>The substantial amount of excavation required would make this option expensive, and therefore likely to be unaffordable. Similarly, there would be a large amount of excavated material that would need to be treated and moved elsewhere. Due to the limited flood risk benefit, this option would be unlikely to provide value for money.</p>

Option 6	
	<p>The option is likely to meet supplier capacity and capability. The option is likely to be achievable.</p> <p>The option does not meet all of the CSFs.</p>
Conclusion	Discounted option

Option 7	
Description	<p>Property Flood Resilience (PFR)</p> <p>Installation of passive PFR measures at the properties on Clydach Terrace.</p>
Cost	Low cost in comparison to other options.
Advantages	<ul style="list-style-type: none"> • Magnitude of property flood damages reduced. This option may be particularly effective in managing residual flood risk from surface water flooding. • Low carbon cost in comparison to other options.
Disadvantages	<ul style="list-style-type: none"> • Properties and people remain at risk of flooding. • Potential for access/egress issues of residents remain in properties during flood events • PFR ineffective in locations prone to deep flood waters (>0.6m). • The effectiveness of this option could be improved with the installation of an effective Flood Warning System for Ynysybwl providing time for residents to evacuated properties. • Installation of PFR as a temporary measure, claims flood risk benefits (through avoided damages) reducing the potential benefits that can be provided and claimed through more wholesale options, therefore impacting their affordability.
Assessment against Critical Success Factors	<p>The PFR option is unlikely to be effective against flooding in a large fluvial event, as depths are likely to exceed the limit of PFR viability (>0.6m depths). However, PFR is suitable for use to address residual flood risk, for example from surface water flooding.</p> <p>The PFR option alone is low cost, affordable, and meets supplier capacity and capability. It is likely to provide value for money. The PFR option is achievable.</p> <p>The option has the potential to partially meet the CSFs.</p>

Option 7	
Conclusion	Not a standalone option but can be incorporated with other options. To be considered at OBC.

Option 8	
Description	<p>Debris Management</p> <p>This option would incorporate multiple methods of reducing blockage risk by managing debris upstream of Clydach Terrace, particularly in the upper catchment. This could be management of bank vegetation or providing screens and mechanical equipment.</p>
Cost	Medium cost
Advantages	<ul style="list-style-type: none"> • Reduces risk of blockages along the river which subsequently decreases the chance of flooding. • May have potential to reduce maintenance costs. • Low to medium carbon cost depending on the approach taken and volumes of debris to be moved.
Disadvantages	<ul style="list-style-type: none"> • Does not improve SoP at Clydach Terrace. • Will have maintenance costs as any debris that is caught on screens will need to be removed. • Potential for loss of vegetation and habitat loss associated with installation of debris catchers or trash screens. • Potential barriers to otter and fish if not considered within design chosen. • If tree thinning is undertaken there may be habitat loss. • Removal of deadwood reduces habitat complexity. • Depending on solution, maybe an eye sore for residents as it will impact the “natural” look of the channel.
Assessment against Critical Success Factors	<p>The flood risk impact of this option cannot be quantified. Measures could be installed to reduce the amount of debris that could enter the channel, but it would not be possible to eliminate debris entering the watercourse from all sources, particularly during high flows. Therefore, the exact impact of this measure in terms of flood risk could not be guaranteed.</p> <p>Will potentially reduce maintenance costs at Clydach Terrace but will increase costs elsewhere as active maintenance in the upper catchment or regular clearing of new trash screens would be required. In the long term, the option may not provide value for money due to ongoing maintenance.</p>

Option 8	
	<p>This option is likely to meet supplier capacity and capability and initial affordability.</p> <p>The option is likely to be achievable.</p>
Conclusion	<p>This option is not considered as a standalone option as it does not have the potential to fully meet all of the CSFs. The impact in terms of flood risk would be difficult to quantify. Not a standalone option but could be incorporated with other options.</p>

Option 9	
Description	<p>Reduce bed level of watercourse and culvert section</p> <p>Lower bed level in the river and culvert section to increase conveyance capacity of river.</p>
Cost	High cost
Advantages	<ul style="list-style-type: none"> • River has additional capacity that may reduce flood risk to some extent.
Disadvantages	<ul style="list-style-type: none"> • Anticipated that the bed level would need to be significantly lowered to accommodate increased flow volume for extreme flood events. Further assessment necessary to determine by how much the bed needs to be lowered. • Loss of habitat. The loss of natural features along the channel and loss of riparian habitat complexity. Potential long term fish passage barrier, and barrier to otter, this would require ongoing mitigation. • Ongoing maintenance necessary to maintain riverbed at certain level, maintenance would prevent re-naturalisation of the watercourse. • Repeated pollution impacts from dredging also to be considered as this would result in a highly modified channel and consequent habitat degradation and reduction in biodiversity. • Medium carbon cost associated with the initial removal of material and ongoing management.
Assessment against Critical Success Factors	<p>Unlikely to meet Strategic Fit and Business Needs as this option is unlikely to provide a significant reduction in present and future flood risk at Clydach Terrace. There may be some reduction, however further work would be needed to quantify the level of bed lowering that would be required to provide a flood risk benefit.</p>

Option 9	
	<p>Achievability is likely to be low due to constraints such as the small working area and proximity to the highway and wall. Bedrock is potentially present in channel which would make lowering bed level more difficult.</p> <p>This option may not match the capacity and capability of potential suppliers due to the site constraints.</p> <p>Due to difficulty in achieving the option, it is unlikely that it will be affordable or provide value for money.</p>
Conclusion	Low potential to meet all CSFs due to lack of flood risk benefit and problems with achievability. This option may not be achievable due to the presence of bedrock in the channel.
	Discounted option.

Option 10	
Description	<p>Widening of river channel</p> <p>Widening of river channel to increase capacity of river.</p>
Cost	High cost
Advantages	<ul style="list-style-type: none"> • River has additional capacity that may reduce flood risk to some extent. • Some potential to re-meander sections of the river which could be beneficial in terms of habitat provision in the long term.
Disadvantages	<ul style="list-style-type: none"> • River would need to be significantly widened to accommodate flooding volume of more extreme events. This would more than likely not be possible due site constraints (highway and properties on one side & steep topography on the other with potentially contaminated legacy spoil). • Widening the river would require large excavation and movement of material which would cause significant habitat loss. • Known invasive non-native plant species such as Japanese knotweed in the area. Soil and excavated material would have to be disposed of correctly. • River would flow closer to the highway wall, with a higher likelihood of erosion impacting the structural integrity of the wall. • Loss of habitat, including potential loss of ancient woodland (Ref PEA p44, Statutory and non-statutory designated sites

Option 10	
	<p>and ancient woodland). The loss of natural features along the channel. As such, permanent impacts expected on aquatic/semi-aquatic species that rely on these habitats. Loss of habitat would require mitigation and compensation under planning policy Wales to demonstrate net benefit for biodiversity.</p> <ul style="list-style-type: none"> • High carbon cost associated with moving large volumes of material.
Assessment against Critical Success Factors	<p>It is considered unlikely that this option alone could meet the strategic fit and business need, as based on the high flow volumes in the river, significant excavation would be required to provide substantial additional capacity. Unlikely that this option alone could provide significant flood risk reduction both now and in future.</p> <p>Potential for high ecological impact, does not align with SMNR principles.</p> <p>Limited potential for achievability based on proximity of the wall and highway.</p> <p>Limited potential for affordability or value for money based on the difficulty of achieving this project option. Similarly, there is limited potential for supplier capacity and capability due to the constraints in implementing this option.</p>
Conclusion	Discounted option.

Option 11	
Description	Raising property level
Cost	High cost due to technical difficulty/infeasibility
Advantages	<ul style="list-style-type: none"> • Living space and all valuables will be above the flood level. The impact of a flood event would be reduced. •
Disadvantages	<ul style="list-style-type: none"> • Residents and properties still within flood risk area, with access and egress issues. Unlikely to increase quality of life of residents. • Likely to disproportionately impact people with reduced mobility who may be less able to use upper floors as their living space. Housing may need adaptation to make upper floors more suitable for living and make access easier.

Option 11	<ul style="list-style-type: none"> • Would need to raise the level of each property significantly to be above the flood level. • Suitability and practicality unlikely given terraced property construction.
Assessment against Critical Success Factors	<p>This option does not meet the strategic fit and business need as the fluvial flood risk is not reduced either in the present day or future. This option reduces the potential consequences of a flood event but does not address the risk. The quality of life of the residents of Clydach Terrace is unlikely to increase substantially as they are still living within area of flood risk.</p> <p>This option is considered to be not practically achievable, due to the characteristics of the existing properties (mainly terraced houses). It would be difficult or impossible to either raise the properties above the flood level or extend the properties to include more storeys.</p> <p>The option is unlikely to meet supplier capacity and capability due to the technical difficulty of this option.</p> <p>The option is unlikely to be affordable or provide value for money due to the complexity of carrying out this option.</p> <p>This option does not meet the CSFs.</p>
Conclusion	Discounted option.

WAW	
Description	<p>Walkaway Involves cessation of all current activities including shoal removal, tree management, inspection, maintenance, repair, and review of existing flood risk. It is considered likely that the highway wall condition will deteriorate once maintenance ceases, increasing risk of breach.</p>
Cost	No cost
Advantages	<ul style="list-style-type: none"> • Reduced ongoing maintenance cost. • Cessation of maintenance would have the potential to allow the river channel to return to a more natural state. If vegetation clearance and de-shoaling were not undertaken, there would be potential benefits in terms of improving habitat complexity,

WAW	
	<p>with associated benefits to important riparian habitat for a range of aquatic and semi-aquatic species.</p> <ul style="list-style-type: none"> • This option has the lowest carbon cost.
Disadvantages	<ul style="list-style-type: none"> • People and properties will be at increasing risk of flooding due to climate change and lack of maintenance. Failure of the wall may be a hazardous breach with no warning. There may be disproportionate impacts of flooding on those with mobility issues, the elderly, or young children, as they will be less physically able to move away from flood waters or may be vulnerable to other health impacts arising from flooding. • Increase in property damage as flood frequency and impact worsens in future. • Residents will continue having to live within the flood risk zone, with associated impacts on wellbeing.
Assessment against Critical Success Factors	<p>Whilst it will save ongoing costs, the Walkaway option increases the present and future fluvial flood hazard to the properties on Clydach Terrace.</p> <p>There are limited wellbeing or community benefits and therefore unlikely to provide improvements in terms of quality of life of Ynysybwl residents.</p> <p>This option matches the capacity and capabilities of potential suppliers as it involves essentially no action to be undertaken.</p> <p>The option is technically feasible.</p> <p>This option does not meet all of the CSFs.</p>
Conclusion	<p>Not recommended but shortlisted for business case purposes as an additional economic baseline for comparison with potential options.</p>

BAU	
Description	<p>Business as Usual</p> <p>Continuation of existing Nant Clydach channel maintenance regime and formalising maintenance of the standard of service (SoS) of the existing highway wall at Clydach Terrace for the purposes of flood risk management.</p>
Cost	<p>The cost of maintaining the existing wall is likely the jurisdiction of RCTCBC. At present, as the wall provides some benefit in terms of flood risk management. The costs associated with maintenance of this structure have been included for the purposes of economic appraisal</p>

BAU	<p>and option comparison under the SOC. Noting this is caveated as the wall maintenance cost was included to showcase the comparison between BAU costs (not only NRW) to the proposed options, and that an incremental breakdown analysis and sensitivity checks will be explored further in OBC stage to clarify cost and liability ownership for potential wall maintenance.</p> <p>Ongoing maintenance costs are likely to increase in future as the wall condition deteriorates. Costs are low in comparison to do-something options.</p>
Advantages	<ul style="list-style-type: none"> • Existing highway wall SoS is maintained. • Current environmental impact is maintained. • Low carbon cost.
Disadvantages	<ul style="list-style-type: none"> • Fluvial flood risk to properties on Clydach Terrace will increase in future. It is likely that with the impacts of climate change flood events will become more frequent and more extreme. • Maintenance cost will continue or increase. Risk that the condition of the wall deteriorates which will require more frequent maintenance or repair to maintain SoS. • Does not contribute to well-being objectives. • Ongoing channel maintenance, including shoal removal, could result in potential reduction in quality of aquatic habitat for fish and invertebrates. • There may be disproportionate impacts of flooding on those with mobility issues, the elderly, or young children, as they will be less physically able to move away from flood waters or may be vulnerable to other health impacts arising from flooding.
Assessment against Critical Success Factors	<p>This option is more affordable in comparison to other options, as it avoids significant capital construction costs. It is likely that costs will increase in future as the condition of the highway wall deteriorates.</p> <p>This option does not fit the strategic fit and business needs as there is no reduction in flood risk in the present day or in future.</p> <p>This option is achievable and further meets the capacity and capability of the supply chain.</p> <p>Limited wellbeing or community benefits and therefore no improvements in terms of quality of life of Ynysybwl residents.</p> <p>This option does not meet all of the CSFs.</p>
Conclusion	<p>Not recommended but shortlisted for business case purposes as the main economic baseline for comparison with potential options used to establish value for money.</p>

Identified Short List

The following options have been carried forward from the longlist exercise. Table 10 shows an assessment of each of the shortlisted options against the Project Objectives and Critical Success Factors. **Options are presented in no order of preference.*

Table 10 Shortlist Option Assessment

Reference to:	Option 1a	Option 1b	Option 3	*Non-standalone		
Description of option:	Upgrade and raise existing highway wall (2% AEP SoP)	Upgrade and raise existing highway wall (1% AEP SoP)	Remove people & properties at high risk of flooding	Additions to the shortlisted options (NFM, increase in PFR, Debris mgmt.)	WAW	BAU
	<u>Project Objectives</u>					
1.	Does reduce fluvial flood risk at the 16 properties up to 2% AEP.	Does reduce fluvial flood risk at the 16 properties up to 1% AEP.	Does reduce flood risk from all sources at the 16 properties for all flood events both now and in future.	N/A as not a standalone option to screen against this objective.	Does not reduce fluvial flood risk to the properties located at Clydach Terrace.	Does not reduce fluvial flood risk to the properties located at Clydach Terrace.
2.	This option might mean that NRW adopts the re-built highway wall and	This option might mean that NRW adopts the re-built highway wall and	Cessation/reduction of maintenance, therefore no/less	Associated with some potential ongoing maintenance	Cessation of maintenance, therefore no ongoing	Maintenance costs as existing, no

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

	<p>takes on maintenance responsibility. However, potential for wall maintenance costs to be offset elsewhere, when considering other factors including post flood event expenditure, and potential for reducing other types of maintenance e.g. shoal removal. Other maintenance costs have potential to decrease.</p>	<p>takes on maintenance responsibility. However, potential for wall maintenance costs to be offset elsewhere, when considering other factors including post flood event expenditure, and potential for reducing other types of maintenance e.g. shoal removal. Other maintenance costs have potential to decrease.</p>	<p>ongoing maintenance costs.</p>	<p>costs however these cannot be accurately forecasted pre-OBC. Needs to be further evidenced in OBC stage.</p>	<p>maintenance costs.</p>	<p>anticipated reduction.</p>
3.	<p>Partially contributes to the NRW well-being objectives. Improves community resilience to flooding and climate change. This option considers solutions which align with SMNR principles, aid in</p>	<p>Partially contributes to the NRW well-being objectives. Improves community resilience to flooding and climate change. This option considers solutions which align with</p>	<p>Improves community resilience to flooding and climate change. Potential for wider benefits, including biodiversity net benefit and increased amenity space depending on how</p>	<p>Partially contributes in principle, to the NRW well-being objectives, but not as a standalone option. Needs to be further</p>	<p>Does not contribute to any of the well-being objectives</p>	<p>Does not contribute to many of the well-being objectives.</p>

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

	nature recovery and improve resilience of communities to climate change. Pollution to the natural environment as a result of urban flooding would be minimised.	SMNR principles, aid in nature recovery and improve resilience of communities to climate change. Pollution to the natural environment as a result of urban flooding would be minimised.	previously built-up land is used.	evidenced in OBC stage.		
4.	This option indicates high adaptive management (ie not BAU), on the appropriate scale of action, whilst promoting collaboration with stakeholders, including public participation. It is evidence based, with the potential for multiple benefits to be realised, both in a local and wider scale. Amongst all, it suggests	Does not contribute to sustainable management of natural resources. A contribution may be made in the wider catchment to ensure a wider benefit is achieved. ***	Does contribute to sustainable management of natural resources both in a local and wider scale.	Contributes in principle to sustainable management of natural resources both in a local and wider scale. Needs to be further evidenced in OBC stage.	Does not contribute to the sustainable management of natural resources.	Does not contribute to the sustainable management of natural resources.

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

	environmental preventative action for the longer term benefits and is building resilience in more than one					
Strategic fit and business needs	Reduces present day and future fluvial flood risk to the properties at Clydach Terrace in the 2% AEP event.	Reduces present day and future fluvial flood risk to the properties at Clydach Terrace in the 1% AEP event	Removes present day and future flood risk from all sources to the properties at Clydach Terrace.	Not a standalone Option	Does <u>not</u> resolve present day and future fluvial flood risk to the properties at Clydach Terrace.	Does <u>not</u> resolve present day and future flood risk to the properties at Clydach Terrace.
Potential achievability	Option is technically feasible to manage flood risk as long as all site constraints are considered and, any social and environmental detrimental impact is mitigated.	Option is technically feasible to manage flood risk as long as all site constraints are considered and, any social and environmental detrimental impact is mitigated.	Option is technically feasible to manage flood risk as long as all site constraints are considered and, any social and environmental detrimental impact is mitigated.	Option technically feasible as an addition to other Options. Needs further evidence to support in OBC stage.	Option is achievable as current maintenance schedule would cease.	Option is achievable since current maintenance schedule would continue.
Supply-side	Option has potential to meet capacity and	Option has potential to meet capacity	Option has potential to meet capacity and	Option has potential to meet	Capacity and capability of	Option meets capacity and

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

capacity and capability	capability of potential suppliers. Further assessment is needed to determine buildability.	and capability of potential suppliers. Further assessment is needed to determine buildability	capability of potential suppliers. Further assessment is needed to determine buildability	capacity and capability of potential suppliers, as an addition to other Options. Needs further evidence to support in OBC stage.	potential suppliers not relevant as maintenance ceases.	capability of potential suppliers since current maintenance schedule would continue.
Potential affordability	Option is considered affordable in comparison to the associated future damage cost limitation. Further assessment is required to determine true cost.	Option is considered affordable in comparison to the associated future damage cost limitation. Further assessment is required to determine true cost.	Option is considered affordable in comparison to the associated future damage cost limitation. Further assessment is required to determine true cost.	Option cost cannot be assessed as standalone at this stage. Needs further evidence to support in OBC stage.	There would be a cost saving as the existing maintenance schedule ceases.	There would be no additional costs associated with maintenance or operation as existing regime continues.
Summary	Potential option	Potential option	Potential option			

In line with the Welsh Government FCERM Business Case Guidance (FCERM-BCG⁴), an economic assessment has been undertaken to determine the present value damages (PVd), present value benefits (PVb) and value for money, in terms of a benefit cost ratio (BCR), of the proposed FRM options.

The FCERM BCG, recommends that two baseline flood damage scenarios are considered for comparison with potential options. In line with Green Book guidance, the BAU option forms the baseline used to establish whether a given option represents value for money. The WAW option is used as an additional baseline for use in the economic assessment of FCERM projects.

A model of the Nant Clydach and catchment has been used to inform the flood risk within the study area. This model was produced in 2022 and comprises a linked 1D-2D ESTRY-TUFLOW model. The model uses a direct rainfall approach in order to explicitly represent the flow routing in the upper catchment. Due to the direct rainfall approach, the model is able to assess flood risk from both fluvial and surface water sources.

An uplift has been applied to account for climate change over the 100 year design life of the project, in line with the available Welsh Government guidance⁵. The Central Estimate value of 5% has been applied in this study for years between 2020-2039, and a 20% allowance has been applied to assess climate change further into the future. The Economics report provides a more detailed breakdown of the Central Estimate for different time periods.

PVd and PVb associated with the individual scenarios are shown in Table 11 below.

Table 11 Summary of the PVd/b

Option (£k)	WAW	BAU	2% AEP SoP Wall	1% AEP SoP Wall	Relocation of properties
Total PVd	11,556	7,236	909	675	4,289
PVd Breakdown	Residential: 11,235 Other: 321	Residential: 6,950 Other: 286	Residential: 810 Other: 99	Residential: 599 Other: 76	Residential: 3,967 Other: 322
Total PVb (Relative to WAW)	-	4,321	10,648	10,882	7,268

The economic Appraisal Conclusion Section on p17 explains a little more about the residual damages as: Relocation of properties option in combination with WAW, has high residual damages associated with the Windsor Cottages from both fluvial flooding and surface water. This significantly impacts the net benefits of this option. The installation of PFR on these properties is unlikely to reduce these damages completely in the WAW scenario as the depth of flooding from the 10% AEP event onwards are deeper than typical design standards for

⁴ Flood and Coastal Erosion Risk Management – Business Case Guidance, June 2019.

⁵ Welsh Government, September 2021 “Flood Consequences Assessments: Climate change allowances” Accessed 22/01/2024 ([Flood Consequences Assessments: Climate change \(gov.wales\)](https://gov.wales/flood-consequences-assessments-climate-change-allowances))

PFR measures. This compares to the lower depth of residual surface water flooding in the BAU scenario and overtopping of the highways walls not predicted to impact these properties until a 0.1% AEP event. Flood warning limitations in this location also pose significant challenges for PFR. Given the complexity of the relocation option, and the potential for wider implications and benefits beyond managing flood risk in Clydach Terrace, variations of this option should be investigated at OBC stage.” i.e. Whilst Clydach Terrace properties are removed, there are other properties on Windsor Cottages which accrue high damages because channel maintenance is ceased.

Cost estimates for the project options have been developed in association with a cost consultant. These costs comprise:

- A capital cost estimate, which has been inflated to 2027 prices based on the programme with Gateway 3 anticipated in 2027; and
- An ‘Other cost, based on high level estimates for utilities diversions, road closures as well as the known unknowns such as NRW staff costs, consultancy fees and land compensations costs. These costs have then been discounted to 2027, the assumed start year of construction; and
- An optimism bias value of 66%, based on best practice recommended in the FCERM-BCG.

Table 12 summarises the cost estimates for each of the shortlisted options. It should be noted that the potential additions to the shortlisted options (such as NFM, increase in PFR etc) are not included in the table below, as the costings are difficult to measure due to uncertainty in scalability. Costings for an alternative flood wall installation methodology using sheet piling were produced. This was investigated due to the potential high cost of utilities diversion. It was deemed worth exploring whether this more expensive method of wall construction would be cheaper overall due to a lessened impacts on the road and services.

Table 12 Summary of Option Estimates

Option	2% AEP SoP Wall (£k)	1% AEP SoP Wall (£k)	1% AEP SoP Sheet Pile Wall (£k)	Relocation of properties (£k)
Total Project Costs	4,188	4,478	4,905	6,900

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

A summary of the estimates for the BAU and shortlisted options is provided in Table 13, expressed as PV costs (PVC) over the 100-year appraisal period.

Table 13 PV Total Estimates

Shortlist PVC Breakdown	WAW (£k)	BAU (£k)	2% AEP SoP Wall (£k)	1% AEP SoP Wall (£k)	Relocation of properties (£k)
PVc Capital	0	0	2,523	2,698	4,157
PVc Operation and Maintenance	0	383	570	570	0
Optimism bias adjustment (66%)	0	252	2,041	2,157	2,743
PV Total Cost	0	635	5,134	5,424	6,900

The PVd, PVC and the net benefit of implementing each of the options are shown in Table 14 below. The PVb represent the difference in damages between the proposed option and the WAW or BAU respectively. The project costs are then used to calculate the BCR as well as the Net Present Value (NPV) of each option. The BCR of each option are also presented relative to the BAU and WAW scenarios for comparison.

Table 14 Summary of Economic Viability

Option	Total PVd (£k)	Total PVb (Relative to WAW) (£k)	Total PVb (Relative to BAU) (£k)	Total PVC (Relative to WAW) (£k)	Total PVC (Relative to BAU) (£k)	BCR (Relative to WAW)	BCR (Relative to BAU)	NPV (Relative to WAW) (£k)	NPV (Relative to BAU) (£k)
WAW	11,556	-	-	-	-	-	-	-	-
BAU	7,236	4,321	-	635	-	6.8	-	3,686	-
2% AEP SoP Wall	909*	10,648	6,327	5,134	4,499	2.1	1.4	5,514	1,828
1% AEP SoP Wall	675*	10,882	6,561	5,424	4,789	2.0	1.4	5,458	1,772

NRW Strategic Outline Case
Ynysybwl Flood Risk Management Project

Relocation of properties	4,289	7,268	2,947	6,900	6,265	1.1	0.5	368	-3,318
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**There are minor sensitivity concerns on these figures due to benefits estimates, however the sensitivity testing that has been undertaken has shown that BCRs remain above unity. This will be explored further at OBC stage.*

The economic appraisal indicates that both wall options provide BCR that are greater than 1 when compared to the BAU scenario, and therefore represent good value for money.

When the wall options are considered against the WAW baseline scenario, they have robust BCR's of 2.1 and 2.0 respectively. Both wall options also provide larger NVP than the BAU relative to the WAW scenario further demonstrating that these options provide good value for money.

Based on the economic appraisal, it is recommended that the two wall shortlisted options are taken forward for more detailed consideration at OBC stage.

The relocation option has a BCR of 0.5 compared to the BAU scenario, and 1.1 against the WAW baseline scenario. There are overriding reasons for recommending this option for further investigation during the OBC stage. It is the only option that remains potentially viable that can remove hazard to the residents of Clydach Terrace. Hazard will be further assessed during the OBC stage and considered when assessing the disadvantages of WAW, BAU and Options 1 and 2.

The option is currently showing residual PVD to other properties, at Windsor Place, that are afforded no improvement in SoP by this option. There is a potential that these damages can be reduced by cost-effective measures such as road reprofiling and or PFR. Reduction of these damages would increase the BCR of this option. PVD and PVb have been estimated using the RAD tool, there is a potential it is over simplifying and underestimating due to the risk profile, as outline in 'Sources and Assumptions below which discuss the potential sensitivities of the RAD Tool analysis. High level sensitivity analysis (outside of the +/- 20% PVc/PVb analysis shown below) has suggested this option has the potential to achieve a BCR of unity or greater compared to BAU. It is recommended improved data and development of increased certainty of the likely true costs be undertaken during the OBC stage. Reduction of cost estimates would further improve the BCR of this option.

Further there are opportunities for this land to be used as a recreational area with the potential for additional benefits that have not been explored at this stage. We recommend that the potential for the delivery of wider benefits as part of this option are explored at OBC.

A summary of the number of properties (Clydach Terrace only) that are shown to be at risk of flooding in each return period is provided in Table 15 for the present day epoch (2026-2069). This property count does not consider properties at risk in the wider community.

It should be noted that the wall raising options provide increased SoP from fluvial flooding only. There is a residual risk of surface water flooding as water backs up behind the wall as

rainfall accumulates. This is represented by the 4 properties and 6 properties still shown to flood in the 2% and 1% AEP events for the 2% AEP SoP Wall and 1% AEP SoP Wall options respectively.

In these flood events, although the properties are observed to be at lower fluvial flood risk, this residual surface water risk is still apparent lowering the overall effective SoP in the area.

Table 15 Summary of Property Count (Present day epoch 2026-2069)

	Flood return period (AEP %)						
	50	20	10	2	1.33	1	0.1
WAW	16	16	16	16	16	16	16
BAU	3	5	6	16	16	16	16
2% AEP SoP Wall	0	0	0	4 (pluvial risk only)	16	16	16
1% AEP SoP Wall	0	0	0	4 (pluvial risk only)	4 (pluvial risk only)	6 (pluvial risk only)	16

At a future stage of investigation, consideration should be given to measures that might be effective in managing this residual risk.

A series of sensitivity analyses have been undertaken to assess the robustness of the economic analysis. The following metrics have been varied:

- Increased present value costs (+20%);
- Decreased present value benefits (-20%).

Table 16 and Table 17 below demonstrate that the wall options maintain BCR values above unity when total project cost estimates are increased by 20% or total project benefits are reduced by 20% demonstrating that these options are economically robust to changes in costs and benefits.

Table 16 Sensitivity Analysis – Increased PVC 20%

Sensitivity Analysis – PVC + 20%					
2% AEP SoP Wall		1% AEP SoP Wall		Relocation of properties	
PV Benefits (£k)	6,327	PV Benefits (£k)	6,561	PV Benefits (£k)	2,947
PV Cost + 20% (£k)	5,318	PV Cost + 20% (£k)	5,666	PV Cost + 20% (£k)	7,683
BCR (relative to BAU)	1.2	BCR (relative to BAU)	1.2	BCR (relative to BAU)	0.4

Table 17 Sensitivity Analysis – Reduced PVb 20%

Sensitivity Analysis – PVb - 20%		
2% AEP SoP Wall	1% AEP SoP Wall	Relocation of properties

NRW Strategic Outline Case
 Ynysybwl Flood Risk Management Project

PV Benefits – 20% (£k)	5,062	PV Benefits – 20% (£k)	5,249	PV Benefits – 20% (£k)	2,358
PV Cost (£k)	4,499	PV Cost (£k)	4,789	PV Cost (£k)	6,265
BCR (relative to BAU)	1.1	BCR (relative to BAU)	1.1	BCR (relative to BAU)	0.4

Options Analysis – Short List Table ⓘ

< Completed at OBC stage >

	Business As Usual (BAU)	Do Minimum	Intermediate	Maximum
Public Sector Cost (or appropriate value for cost)				
Appropriate cost benefit Ratio				
Significant unmonetisable costs/benefits				
Significant unquantifiable benefits				
Risk cost				
Residual optimism bias (if applicable)				
Switching values of key variables				
Life span of option				
Net Present Social Value				

Recommended Option

~~<Completed at OBC stage>~~

~~<Outline the recommended preferred way forward (scope, solution, service delivery, implementation and funding) for the project>~~

No option has been recommended at this stage, as there are several factors which need consideration and more robust evidence will be investigated at OBC stage.

Sources and Assumptions

The following sources of data have been used:

- Flood model outputs from the 2022 direct rainfall model; and
- National Receptor Database (2023), which contains point features for each receptor in the study area; and
- Land Registry House Price Index (2023) – average market value for each type of residential property for Wales
- GDP Deflator information⁶ provided by the UK Government (December 2023 issue)
- Ordnance Survey (OS) MasterMap (provided by NRW in 2022)

Although typical best practice guidance has been adhered to in the process of undertaking the economic appraisal and hydraulic modelling assessment, a number of assumptions have been made.

The economic assessment has been undertaken using the RAD tool, which is a simplification of the method prescribed for economic analysis in the Multi-Coloured Manual. The tool is considered appropriate for use in initial high-level assessments, however it should be noted that the tool does not provide the same level of analysis as a full economic assessment for a business case. Limitations of the RAD method include:

- Additional costs relating to the damage of vehicles, evacuation, hazard, intangible impacts to health and emergency responses are reported on a “per residential property” basis. The tool does not provide any additional prescriptive guidance on the

⁶ <https://www.gov.uk/government/collections/gdp-deflators-at-market-prices-and-money-gdp>

⁷ Environment Agency Guidance - Practical guidance on determining asset deterioration and the use of condition grade deterioration curves: Revision 1. SC060078/R1.
https://assets.publishing.service.gov.uk/media/6034c3b7e90e076607c1bf31/_SC060078_Guidance_Report.pdf

evaluation of these additional damages, and the “per property” value is therefore an average of expected costs from a range of property types.

- The tool focuses on determining residential property damages, but it does offer an estimate of non-residential damages, but this is limited to the provision of a single non-residential sector average damage.
- The tool includes a high-level estimate of additional expenditure incurred by emergency services and organisations responsible for responding to flood events. The estimate is based on a 10% uplift to the “total property related damages”.
- As advocated by FCERM-BCG, all property related damage are capped to the “risk free market value”. However, the RAD tool uses generalised residential capping values have been derived using the Welsh national average house price based on the UK House Price Index (Land Registry, 2018). Therefore, the house prices are not necessarily reflective of the study area.
- The RAD tool methodology dilutes the assessment of hazard and does not allow consideration of the lack of flood warning due to the challenges to provide timely flood warning in this upper catchment that has observed severe and rapid flooding. This leads to an underestimation of these damages and risks, particularly in the withdrawal option where there would be no flood warning available.

Additional to the implementation of the RAD tool the biggest limitation of the appraisal is that the 1 in 2 (50% AEP), 1 in 5 (20% AEP) and 1 in 10-year (10% AEP) events have not been modelled for the shortlist options which include raising of the highway wall height. This is because the proposed flood wall does not overtop until the 50-year and 100-year (2% and 1% AEP) events respectively, and therefore the risk of flooding from the Nant Clydach is removed for the lower order flood events.

However, as previously discussed there is a secondary flood mechanism of surface water flows being trapped behind the flood wall that are unable to discharge into the watercourse. As these return periods have not been modelled, we have assumed that no properties are at risk of internal flooding from the residual surface water risk in these scenarios. This assumption leads to potential overestimation of the benefits of the flood walls. It is considered that this high level assumption is appropriate at this stage of assessment.

The hydraulic modelling was undertaken primarily in 2022, using topographic and channel survey obtained for the purposes of the study. The catchment is ungauged, however model verification was undertaken to physical evidence of the flooding that occurred during Storm Dennis, including wrack marks. The model was able to broadly reproduce the flood extents observed during this flood event, however modelled levels were somewhat lower than observed in the wrack marks. The lack of data to calibrate the model remains the main limitation of the modelling study. At OBC stage the freeboard / residual uncertainty allowance to the existing wall needs to be considered further, as it would increase the flood risk and hence damages, thus also affecting benefits.

Project Plan

The outline Project Plan for the SOC stage is embedded below. The more detailed generic Project Plan is available upon request.



Ynysbwl Outline SOC
Stage Project Plan.pdf

Gateway 0 – Initiation	Summer 2023	Project brief approval and procurement of key supply chain
Gateway 1 – Options Short listing	Spring 2024	SOC (target date)
Gateway 2 – Options Selection	Spring 2025	OBC
Gateway 3 – Approved for delivery	Winter 2026	FBC
Gateway 4 – Delivery Handover Completion	Spring 2028	Construction
Gateway 5 – Project Closure	Spring 2029	12 months defects period

Project Start Date <i>(Original start date)</i>	30/06/2023	Project Completion Date <i>(Forecast)</i>	31/03/2029
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Benefits Delivery

Benefits will be investigated, tracked and reported on throughout the project. Benefits will be maximised at optioneering stage including community benefits directly resulting from this project, working with our supply chain partners.

Project Products

Table 20 – Project Products

Product (Links to DMS Area or embedded documents)	Date produced
Hydraulic model of study area	Baseline model produced June 2022, further option modelling undertaken in November 2023 and January 2024
Preliminary Ecological Appraisal (PEA)	First issue 17 January 2024
Longlist modelling report	March 2024
Shortlist modelling report	March 2024
Equality Impact Assessment	March 2024
Strategic Environmental Review	March 2024
Economic appraisal	March 2024
Preliminary WFD Assessment	February 2024